UNIVERSITY OF DELHI

CNC-II/093/1(22)/2022-23/212
Dated: 06.10.2022

NOTIFICATION

Sub: Amendment to Ordinance V

[E.C Resolution No. 18-1-3 dated 18.08.2022]

Following addition be made to Appendix-II-A to the Ordinance V (2-A) of the Ordinances of the University;

Add the following:

Syllabi of Semester-I of the following departments under Faculty of Science based on Under Graduate Curriculum Framework -2022 to be implemented from the Academic Year 2022-23.

FACULTY OF SCIENCE

DEPARTMENT OF BOTANY

BSc. (Hons.) Botany
Category-I

DISCIPLINE SPECIFIC CORE COURSE – 1: Plant Diversity and Evolution

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Plant Diversity and Evolution	**DSC-1**	**2**	0	**2**	10+2 from any recognized Board with Biology & Candidates must appear in CUET in the following subject combination: **Physics+ Chemistry+ Biology/Biotechnology**	**Nil**

Learning Objectives

The Learning Objectives of this course are as follows:

- To make students aware about the diversity of plants and microbes present on the planet and how are they possibly related to each other in light of evolution.

Learning outcomes

The Learning Outcomes of this course are as follows:

By studying this course students will gain basic knowledge on

- The diversity of plants and microbes
- Their general characteristics
- Various groups of plants and their evolutionary relationships
- Basic principles and concepts of evolution that contribute to plant diversity

SYLLABUS OF DSC-1

Unit1: Origin of life **Hours: 6**

Principles and concepts of evolution, Tree of Life, and classification (upto six kingdoms)

Unit2: Bacteria **Hours: 4**

General characteristic features, cell structure, asexual reproduction and modes of gene transfer (conjugation, transformation and transduction), brief introduction to Archaebacteria.

Unit3: Viruses **Hours: 4**

General characteristic features, replication, RNA virus (structure ofTMV), DNA virus (structure of T-phage), Lytic and Lysogenic life cycle (Lambda phage).

Unit4: Algae **Hours: 6**

General characteristic features, cell structure, range of thallus, methods of reproduction and evolutionary classification (only upto groups). Brief account of *Spirogyra*, *Sargassum*.

Unit5: Fungi **Hours: 8**

General characteristic features, reproduction and broad classification. Myxomycetes and their similarities with fungi, plants and animals, Brief account of *Rhizopus*, *Agaricus*. Introduction to lichens.

Unit6: Bryophytes **Hours: 8**

General characteristic features and reproduction, adaptation to land habit, broad classification, evolutionary trends in Bryophytes. Brief account of *Marchantia*, *Funaria*.

Unit7: Pteridophytes **Hours: 8**

General characteristic features and reproduction, broad classification, evolutionary trends in Pteridophytes, affinities with Bryophytes. Brief account of *Adiantum*, *Selaginella*.

Unit8: Gymnosperms **Hours: 8**

General characteristic features and reproduction, broad classification, evolutionary trends in Gymnosperm, affinities with Pteridophytes. Brief account of *Gnetum*, *Ephedra*.

Unit9: Angiosperms **Hours: 8**

General characteristic features and reproduction, Concept of natural, artificial and phylogenetic system of classification. Affinities with Gymnosperms.

Practical component (60 Hours)

1. To study structure of TMV and Bacteriophage (electronmicrographs/models). **(01)**

2. To study morphology of *Volvox*, *Oedogonium*, *Chara*, *Fucus* and *Polysiphonia* (Temporary preparation/specimens/slides). (02)

3. To study *Rhizopus*, *Penicillium*, *Alternaria* (Temporary preparations), symptoms of rust of wheat, white rust of crucifer (specimen). (02)

4. To study *Marchantia* (morphology, WM of rhizoids and scales), *Anthoceros* (morphology), *Sphagnum* (morphology, WM of leaf), *Funaria* (morphology WM of rhizoid and leaf). (02)

5. To study *Selaginella* (morphology, WM of strobilus and spores), *Equisetum* (morphology, WM of spores), *Pteris* (morphology, tease mount of sporangia and spores). (03)

6. To study *Cycas* (morphology, leaf, leaflet anatomy, coralloid root, bulbils, megasporophyll and microsporophyll); *Pinus* (morphology of dwarf shoot, needle anatomy, male and female cones, WM pollen grains). (02)

7. To study variation in leaf venations in dicots and monocots (at least two specimens each). (01)

8. To study the types of inflorescences in angiosperms (through specimens).(01)

9. To study the types of fruits in angiosperms (through specimens). (01)

Essential/recommended readings

- Campbell,N.A.,Reece,J.B.(2008.)Biology,8thedition,PearsonBenjaminCummings,San Francisco.
- Evert,RF.,Eichhorn,S.E.(2012).RavenBiologyofPlants,8thedition, NewYork,NY: W.H.Freeman and Company.
- Bhatnagar,S.P.,Moitra,A.(1996).Gymnosperms.NewDelhi,Delhi:NewAgeInternational(P)

Ltd Publishers.

- Kumar,H.D.(1999).IntroductoryPhycology,2ndedition.Delhi,Delhi:AffiliatedEast-West. Press Pvt. Ltd.
- Pelczar,M.J.(2001).Microbiology,5thedition.NewDelhi,Delhi:TataMcGraw-HillCo.
- Puri,P.(1985).Bryophytes.NewDelhi,Delhi,AtmaRam andSons.
- Sethi,I.K.andWalia,S.K.(2018).TextbookofFungiandTheirAllies.(2ndEdition),Medtech Publishers, Delhi.
- Tortora,G.J.,Funke,B.R.,Case.C.L.(2007).Microbiology.SanFrancisco,U.S.A:Pearson Benjamin Cummings.
- Vashishta,P.C.,Sinha,A.K.,Kumar,A.(2010).Pteridophyta.NewDelhi,Delhi:S.Chand &Co Ltd.
- Singh,G.(2019)PlantSystematics-AnIntegratedApproach.4th edition.CRCPress,TaylorandFrancisGroup.
- Blackmore,S.,Crane,P.(2019)HowPlantsWork–Form,Diversity,Survival,PrincetonUniversity Press; Illustrated edition
- Ingrouille,M.,Eddie,B.(2006)Plants:EvolutionandDiversity.CambridgeUniversityPress.

Suggestive readings

- Parihar,N.S.(1991).AnIntroductiontoEmbryophyta.Vol.II.Pteridophytes.Prayagraj:U.P.: CentralBook Depot.
- Singh,V.,Pandey,P.C.,Jain,D.K.(2001).ATextBookofBotany.Meerut,UP:Rastogiand Co.
- Webster,J.,Weber,R.(2007).IntroductiontoFungi.Cambridge,CambridgeUniversityPress.

Note: Examination s cheme a nd mode s hall be a s pr escribed by t he E xamination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 2: Cell Biology: Organelles and

CREDIT DI STRIBUTION, E LIGIBILITY AND PRE-REQUISITES O F TH E COURSE

Course t itle & Code	Credits	Credit di stribution o f t he course			Eligibility criteria	Pre-requisite of t he course (if any)
		Lecture	Tutorial	Practical/ Practice		
Cell Biology: Organelles and Biomolecules	DSC-2	**2**	0	**2**	10+2 from any recognized Board with Biology & Candidates must appear in CUET in the following subject combination: **Physics+Chemistry+ Biology/ Biotechnology**	**Nil**

Learning Objectives

The Learning Objectives of this course are as follows:

- Cell as a structural and functional unit of life.
- Types of biomolecules (proteins, carbohydrates, lipids and nucleic acids) and their roles in cell structure and function.
- Structures of different organelles and their role in fundamental metabolic processes of a cell.

Learning outcomes

The Learning Outcomes of this course are as follows:

By studying this course students will gain basic knowledge on

- The relationships between the properties of macromolecules, their cellularactivities and biological functions.
- Physico-chemical composition of organelles and their functional organization.
- Basic principles and concepts of evolution that contribute to plant diversity.

SYLLABUS OF DSC-2

Unit 1: Biomolecules **Hours: 10**

Types of chemical bonds and their biological significance. Structure and biological roles of carbohydrates, lipids, proteins and nucleic acids. ATP: structure and its role as an energy currency molecule.

Unit 2: The Cell **Hours: 04**

Cell as a unit of structure and function; Characteristics of prokaryotic and eukaryotic cells; Origin of eukaryotic cell (Endosymbiotic theory).

Unit 3: Cell Wall and Plasma Membrane **Hours: 06**

Chemistry, structure and function of Plant Cell Wall. Singer and Nicolson's fluid mosaic model of cell membrane.

Unit 4: Cell Organelles: Structure and function of the following Organelles

Hours: 11

Nucleus: Structure and function (nuclear envelope, nuclear pore complex, nuclear lamina); types of chromatins; nucleolus.
Chloroplast and Mitochondria: Structural organization; Function; Semi- autonomous nature of mitochondria and chloroplast.
Endomembrane system: Endoplasmic Reticulum – Structure and function of RER and SER, protein folding, processing in ER, export of proteins and lipids; Golgi Apparatus Organization, protein glycosylation, protein sorting and export from Golgi Apparatus. Introduction to post- translational modifications.
Peroxisome and Lysosomes: Structure and function.

Cytoskeleton: Role and structure of microtubules, microfilaments, intermediary filament and motor proteins.

Unit 5: Cell division **Hours: 08**

Eukaryotic cell cycle, mitosis and meiosis; regulation of cell cycle.

Practical component (60 Hours):

1. Study of cell and its organelles with the help of electron micrographs and other digital resources. (02)
2. Study of plant cell structure with the help of epidermal peel mount of *Allium*/*Rhoeo*/*Crinum*. (01)
3. Microchemical tests for carbohydrates (reducing, non-reducing sugars and starch), lipids and proteins. (02)
4. Separation of chloroplast pigments by paper chromatography/ Thin Layer Chromatography. (01)
5. Separation of amino acids by paper chromatography. (01)
6. Study the effect of organic solvent and temperature on membrane permeability. 02
7. Demonstration of the phenomenon of protoplasmic streaming in *Hydrilla* leaf. (01)
8. Demonstration of the phenomenon of plasmolysis and deplasmolysis. (01)
9. Demonstration of separation of biomolecules by dialysis. (01)

Essential/recommended Readings:

- Hardin, J. and Lodolce, J.P. (2022). Becker's World of the cell, 10th edition, Pearson
- Berg, J.M., Tymoczko, J.L., Stryer, L. (2011). *Biochemistry*. New York, NY: W. H. Freeman and Company.
- Campbell, N. A. (2020). Biology: A Global Approach, 12th Edition, Pearson
- Campbell, P.N., Smith, A.D. (2011). *Biochemistry Illustrated*, 4th edition.London, UK: Churchill Livingstone.

Suggested readings:

1. Cooper, G.M., Hausman, R.E. (2019). The Cell: A Molecular Approach, 7th edition. Sinauer/OUP.
2. Iwasa, J, Marshall , W. (2020). Karps's Cell Biology, 9th edition, New Jersey, U.S.A.: John Wiley & Sons.
3. Majumdar, R., Sisodia, R. (2019). Laboratory Manual of Cell Biology, with reference to Plant Cells. New Delhi, Delhi: Prestige Publication.
4. Nelson, D.L., Cox, M.M. (2021). Lehninger Principles of Biochemistry, 8th edition. New York, NY: W.H. Freeman and Company.
5. Reven, F.H., Evert, R.F., Eichhorn, S.E. (1992). Biology of Plants. New York, NY: W.H.Freeman and Company.
6. Tymoczko, J.L., Berg, J.M., Stryer, L. (2012). Biochemistry: A short course, 2nd edition. New York, NY: W.H.Freeman and Company.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 3: Basic Laboratory and Field Skills in

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Basic Laboratory and Field Skills in Plant Biology	**DSC-3**	**2**	**0**	**2**	10+2 from any recognized Board with Biology & Candidates must appear in CUET in the following subject combination: **Physics+ Chemistry+ Biology/ Biotechnology**	**Nil**

Learning Objectives

The course will help students gain knowledge about:

- To learn fundamental skills important for performing laboratory and field experiments

Learning outcomes

This course will be able to demonstrate basic knowledge and understanding of:

- Good laboratory practices, management of laboratory waste, understanding hazards and risks to ensure a safe laboratory environment.
- Basics of measurements, units and common mathematical calculations, sampling and data collection.
- Operation and maintenance of instruments
- Presentation, analysis of data and interpretation of results.

SYLLABUS OF DSC-3

Unit 1: Lab safety and good lab practices **Hours: 08**

General laboratory safety, good laboratory practices, biosafety measures (first-aid practices to be followed in case of burn, acid spills and injury), safety symbols, lab safety equipments (fire extinguisher, fume hood, safety glasses), classes of laboratory chemicals, maintenance and handling of chemicals (Labels, Quality - LR/ AR/ Molecular biology grade/ HPLC grade; Expiry date; Precautions for use), Disinfectants, Biocontainment, Disposal of hazardous chemicals, radioactive and biological waste, Laboratory waste management.

Unit 2: Use and maintenance of Laboratory equipment **Hours: 08**

Weighing balance (Top loading and Analytical), pH meter (calibration and use), magnetic stirrer, pipettes and micropipettes, autoclave, laminar airflow, BOD incubator, incubator shaker, micrometer, haemocytometer, spectrophotometer, Agarose gel electrophoresis unit, SDS PAGE unit, centrifuge, distillation unit, conductivity meter, Lux meter.

Unit 3: Microscopy, sample and slide preparation **Hours: 05**

Microscopes (Dissecting, Compound and Electron microscopes), Fixation and Preservation (for light and electron microscopy); staining, mounting; basic introduction to other types of microscopes (Confocal, Fluorescence)

Unit 4: Measurements and calculations **Hours: 04**

Units of measurements and conversion from one unit to another, measurement of volumes of liquids, Weighing, calculations: scientific notations, powers, logarithm and fractions.

Unit 5: Solutions and Buffers **Hours: 04**

Molarity, Molality, Normality, percent solution, stock solution, standard solution, dilution, dilution series, pH, acids and bases, buffers - phosphate, Tris- acetate, Tris- Cl and Citrate buffer.

Unit 6: Basic culturing techniques **Hours: 06**

Basic culture media (LB, YEB, MS)- liquid and solid, Culture techniques: plating (streak, spread & pour), replica plating, serial dilution.

Unit 7: Data collection, statistical analysis and interpretation **Hours: 08**

Fundamentals of data collection, data types - primary and secondary, methods of data collection, sample, sampling methods - merits and demerits, technical and biological replicates, classification - tabulation and presentation of data, Descriptive statistics - Mean, Mode, Median, Variance, Standard Deviation, Standard error, Coefficient of Variation, difference between sample mean and population mean.

Unit 8: Basic computer skills for biology **Hours: 08**

MS-Word, PowerPoint, Excel, introduction to biological databases.

Unit 9: Field Skills **Hours: 04**

Identification, collection, cataloguing and preservation of plant specimens, Herbarium and Museum.

Practical component (60 Hours):

1. Preparation of solutions- molar, molal, normal, percentage, stock, standard and serial dilution (01)
2. Determining pH of solutions (pH paper, Universal indicator, pH meter) and preparation of buffers (Phosphate, Tris-Cl, Electrophoresis buffers - TBE/TAE) (01)
3. Working of instruments -light microscope, autoclave, laminar air flow, spectrophotometer, centrifuge, gel electrophoresis unit (Agarose & Poly acrylamide). (01)
4. Temporary peel mount slide preparation and staining (safranin and acetocarmine). (01)
5. Calculate cell size using micrometer. (01)
6. Calculate number of cells (pollen/spores) using haemocytometer. (01)
7. Preparation of LB medium, growth and maintenance of bacterial cultures (liquid -serial dilution method; and semi-solid cultures - streak, spread and pour plates) (02)
8. Isolation of genomic DNA from *E. coli* and plant leaf material, Agarose gel electrophoresis (01)
9. Calculation of mean, mode, median, standard deviation using data set (collected from experiments 5,6). (01)
10. Using software to draw tables, graphs and calculating descriptive statistics (Microsoft Excel (01)
11. Laboratory safety equipment (Fire extinguisher, Fume hood, safety glasses) (01)
12. Mounting of a properly dried and processed plant specimen with herbarium label. (01)

Essential/recommended Readings:

- Evert, R. F., Eichhorn, S. E., Perry, J.B. (2012). Laboratory Topics in Botany. W.H. Freeman and Company.
- Mesh, M.S., Kebede-Westhead, E. (2012). Essential Laboratory Skills for Biosciences. John Wiley & Sons, Ltd.
- Mu, P., Plummer, D. T. (2001). Introduction to practical biochemistry. Tata McGraw-Hill Education.
- Mann, S. P. (2016). Introductory Statistics, 9th edition. Hoboken, NJ, John Wiley and Sons Inc.
- Danniel, W.W. (1987). Biostatistics. New York, NY: John Wiley Sons.
- Jones, A.M., Reed, R., Weyers, J. (2016). Practical Skills in Biology, 6th Edition, Pearson
- Bisen, P.S. (2014). Laboratory Protocols in Applied Life Sciences, 1st edition. CRC Press.

Suggested readings:

- Zar, Z. H. (2010). Biostatistical Analysis, 5th edition, Pearson Prentice Hall, New Jersey, USA.

Note: E xamination s cheme a nd mode s hall be a s pr escribed by t he E xamination Branch, University of Delhi, from time to time.

COMMON POOL OF GENERIC ELECTIVES (GE) COURSES
Offered by Department of Botany
Category-IV

GENERIC ELECTIVES (GE-1)

Credit distribution, Eligibility and Pre-requisites of the Course

Course t itle & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Plant Diversity and Human Welfare	4	2	0	2	12th Pass	NIL

Learning Objectives

The Learning Objectives of this course are as follows:
Build awareness about the different groups of plants and their roles in supportinghuman life.

Learning outcomes

After studying this course the student will gain knowledge about:

- the diversity of various groups of plants, their characteristics and identification.
- different phytogeographic zones in India.
- the basic principles of conservation of Biodiversity and Sustainable DevelopmentGoals (SDG).
- the role of plants in human welfare.

SYLLABUS OF GE-1

Unit 1: Understanding biodiversity

Hours: 06

Understanding biodiversity - definition of key terms; plant diversity in India; assigning value to plant diversity; economic and ecological importance of algae, bryophytes, pteridophytes and gymnosperms; insights into flowering plant diversity with special focus on agrobiodiversity.

Unit 2: Crop diversity

Hours: 08

Crop diversity in various phytogeographic regions in India and their traditional importance as food (including cereals, pulses, oil crops, spices, beverages, fruits and nuts, vegetables, condiments), medicines (Ashwagandha and Sarpagandha) and adornments

Unit 3: Role of forests

Hours: 06

Forests, woodlands, and vegetation stands: diversity and their importance in ecological, aesthetic, and overall well-being; social dimensions of plant diversity; commercial value and utilization of plant wealth.

Unit 4: Cash Crops

Hours: 5

Crops of high economic value (tobacco, sugarcane, cotton, basmati rice, sandalwood, saffron); Petro crops: the future industry (*Jatropha* sp., corn and sugarcane).

Unit 5: Conservation of biodiversity

Hours: 3

Conservation of biodiversity using community driven conservation strategies, sustainable utilization keeping Sustainable Development Goals (SDGs) in mind, Innovative approaches and traditional methods of biodiversity utilization and waste minimization during product formation.

Unit 6: Policy issues in conservation of Biodiversity

Hours: 02

National and International initiatives and programmes/schemes focussing on Plant Diversity and human welfare (Tribal Rights Bill, Convention on Biological Diversity (CBD), International Union for Conservation of Nature (IUCN), Protection of Plant Varieties and Farmers' Rights Authority (PPVFRA).

Practicals: (60 Hours)

1. To study local plant diversity (common algae, bryophytes, pteridophytes, gymnosperms

(any two of each) in and around the campus; and understand their ecological and economic importance.

2. Microchemical tests for carbohydrates, proteins and oils.
3. To study (any three) commonly found tree species in the vicinity and understand their role in human welfare.
4. To prepare an inventory of common medicinal plants in your campus (identify to the family level, list their uses in Indian System of Medicines)
5. To visit the local parks and list the trees planted. Also assess some for their dust pollution mitigation capacity using standard procedures.
6. Industrial visit to see how the drugs are extracted from plants (report to be submitted for evaluation).

Essential/recommended readings

1. Bilgrami, K. S. (1998). Phytodiversification and Human Welfare: Dedicated to Late Prof. KS Bilgrami, FNA (1933-96). MD Publications Pvt. Ltd.
2. Utting, P. (2013). Trees, People and Power. Routledge.
3. Manoharachary, C., Nagaraju, D. (2016). Medicinal plants for human health and welfare. Ann. Phytomed, *5*(1), 24-34.

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Suggestive reading

Myers, N. (2019). A wealth of wild species: storehouse for human welfare.Routledge

GENERIC ELECTIVES (GE-2)

Credit distribution, Eligibility and Pre-requisites of the Course

Course t itle & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite o f the course
		Lecture	Tutorial	Practical/ Practice		
Biofertilizers	4	2		2	12th Pass	**Nil**

Learning Objectives

The Learning Objectives of this course are as follows:

- To develop an understanding of biological systems used as fertilizers and build skills in handling microbial inoculants.
- To understand the optimum conditions for growth and multiplication of useful microbes such as *Rhizobium*, cyanobacteria, mycorrhizae, *Azotobacter* etc.
- To understand the role of microbes in mineral cycling and nutrition of plants.
- To gain expertise in various methods of decomposition of biodegradable waste, conversion into compost and apply this knowledge and skill in their daily life.

Learning outcomes

On successful completion of this course, a student will be able to:

- visualize and identify different types of microorganisms with a compound microscope.
- understand the classification of microorganisms according to their shape/ structure for morphological identification. Prepare and sterilize different types of culture media.
- isolate of microorganisms from the environmental samples and culture in aseptic conditions.

SYLLABUS OF GE-2

Unit 1: Introduction

Hours: 7

Introduction to microbial inoculants or biofertilizers, macro and micro nutrition of plants, chemical fertilizers versus biofertilizers; Methods and steps in mass multiplication of biofertilizers: stock culture, broth culture, growth medium, fermentation, blending with the carrier, packaging, and quality check, ISI standard specification for biofertilizers; scope of biofertilizers in India.

Unit 2: Microbial Inoculants

Hours: 08

Study of important microbial inoculants: *Rhizobium*, *Azospirillum*, *Azotobacter*, Actinorhizae; Characteristics, isolation, identification, and crop response.

Unit 3: Role of Cyanobacteria

Hours: 02

Role of Cyanobacteria (blue-green algae) in rice cultivation; *Azolla* and *Anabaena azollae* association, nitrogen fixation, and factors affecting growth.

Unit 4: Mycorrhizal association

Hours: 08

Types of mycorrhizal association, taxonomy, occurrence and distribution; Role of Arbuscular mycorrhizal fungi in phosphorus nutrition, growth and yield of crop plants;AMF – methods in isolation (wet sieving and decanting), identification (morphological and molecular methods). Methods of inoculum production (Pot culture and root culture).

Unit 5: Organic farming

Hours: 5

Introduction to organic farming, recycling of biodegradable municipal (domestic), agricultural and industrial waste; green manuring, bio-composting, vermicomposting and their field application.

Practicals: (60 Hours)

1. Study of *Rhizobium* from root nodules of leguminous plants by Gram staining method. **Hours: 01**
2. Observation of arbuscular mycorrhizal fungi from plant roots. **Hours: 02**
3. Isolation of arbuscular mycorrhizal spores from rhizosphere soil. **Hours: 01**
4. Isolation of *Anabaena* from *Azolla* leaf. **Hours: 01**
5. Study of Earthworm, *Azolla*, AMF: Arbuscules-vesicles through specimen / digital resources. **Hours: 01**
6. Study of Biocontrol methods and their application -Pheromone trap, *Trichoderma*, *Pseudomonas*, Neem etc. through digital resources. **Hours: 01**
7. Rapid test for pH, $NO3^{-}$, $SO4^{2-}$, Cl^{-} and organic matter of different composts. **Hours: 02**
8. Projects on any one of the following topics: *Rhizobium* technology, AMF technology, Organic farming, Bio composting, Vermicomposting, *Azolla* culture etc. (The design of the project should be such that it includes a continuous work of at least 6 Hours and a dissertation submission). **Hours:06**

Essential/recommended readings

- Kumaresan, V. (2005). Biotechnology. New Delhi, Delhi: Saras Publication.
- Sathe, T.V. (2004). Vermiculture and Organic Farming. New Delhi, Delhi: Daya publishers.
- Subha Rao, N.S. (2020). Soil Microbiology, 5th edn. New Delhi, Delhi: Oxford & IBH Publishers.
- Reeta Khosla (2017). Biofertilizers and Biocontrol Agents for Organic Farming, Kojo Press

Suggestive readings

- *Azotobacter* - Isolation and characterization - https://youtu.be/1Z1VhgJ2h6U
- *Rhizobium* - Identification and characterization - https://youtu.be/jELlo-pMvc4.
- 3-Days Online Workshop On Arbuscular Mycorrhizal Fungi - Biodiversity, Taxonomy and Propagation 19-2 (2022-01-20 at 02_27 GMT-8) - https://youtu.be/LKzK4IuSRc4.
- Vayas, S.C, Vayas, S., Modi, H.A. (1998). Bio-fertilizers and organic Farming. Nadiad, Gujarat: Akta Prakashan.

GENERIC ELECTIVES (GE-3)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Protected Agriculture – Hydroponics and Organic Cultivation	4	2		2	12th Pass	**Nil**

Learning Objectives

The Learning Objectives of this course are as follows:

- To provide knowledge and expertise of various aspects of hydroponics, aquaponics and organic cultivation to the students.
- To make students economically self-reliant by growing and marketing organic herbs, vegetables, microgreens and fruits.

Learning outcomes

- The Learning Outcomes of this course are as follows:
- Students will develop a thorough understanding of the concept of Hydroponics, Aquaponics and Organic farming.
- Students will be trained in establishing hydroponic facility. Students will learn the development of various organic products such as biopesticides, biofertilizers and biogrowth promoters.
- Students will understand various government policies in marketing of hydroponicand organic produce.
- Understand Good Agricultural Practices associated with protected agriculture.

SYLLABUS OF GE-3

Unit 1: Introduction to Protected Agriculture

Hours: 02

Protected Agriculture types (hydroponics, aquaponics and organic farming), definition history, terminology, importance and advantages over traditional agriculture, limitations and challenges.

Unit 2: Plant Growth Requirements and Media formulations

Hours: 5

Physical parameters - light (quality and quantity) artificial light, light balancers; pH, conductivity, salinity (Dissolved Oxygen-DO, Total Dissolved Solid - TDS) andtemperature; Chemical parameters- mineral nutrient requirements, deficiencies, toxicities, growth regulators (auxins, gibberellins, cytokinins and abscisic acids); Growth media- types, properties, uses, nutrient formulae, preparation of solutions, solid Media and nutrient film.

Unit 3: Hydroponic growing systems

Hours: 7

Basic concepts and designs (closed and open systems techniques Nutrient Film Technique (NFT), Deep Water Culture (DWC), Dutch Bucket and other small-scale systems), systems layout. Strengths and weaknesses of various systems, site considerations, componentry, nutrient delivery, pumping

Unit 4: Hydroponics associated pest and diseases

Hours: 06

Hydroponics associated pest - mites, thrips, whiteflies, leaf miners; Identification and management of diseases -bacterial, fungal and viral diseases; safety practices (Good Agricultural Practices (GAP) and Integrated Pest Management (IPM).

Unit 5: Organic farming and its management

Hours: 06

Organic farming and associated management practices (nutritional requirements, pest, diseases, weeds); use of biofertilizers, biopesticides, bioherbicides, biocontrol agents (plant growth promoting rhizobacteria (PGPR), pheromone trapping, *Trichoderma*, *Pseudomonas*, neem oil, garlic etc.) in management.

Unit 6: Marketing and Policies

Hours: 04

Marketing of the produce and government institutes and policies related to protected farming (hydroponics and organic farming).

Practicals: (60 Hours)

1. Study of various instruments used in hydroponics.
2. Preparation of growth media for hydroponics.
3. Estimation of NPK, DO, TDS, pH of growing media
4. Demonstration of different irrigation techniques in hydroponics.
5. Demonstration of construction of a sustainable hydroponic unit.
6. Perform rapid tests for estimation of NPK in different soil samples (at leastthree).
7. Bulk density and porosity of soilless media e.g. coco-peat, perlite, vermiculite, expanded clay, rockwool (any two media).

8. Demonstration of growing a leafy vegetable/fruity vegetable/ medicinal herb/aromatic plant in Hydroponics solution.
9. Study of traditional organic inputs and formulation of biofertilizer.
10. Preparation of biopesticides, plant health promoters like *Panchgavya*, *Beejamrut* etc. Field visit to organic farm/hydroponic farm and submission of visit report.

Essential/recommended readings

- Schwarz, M. (1995). Soilless Culture Management. Advanced Series in Agricultural Sciences, vol. 24. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-79093-5_2.
- Hasan, M., Sabir, N., Singh, A.K., Singh, M.C., Patel, N., Khanna, M., Rai, T., Pragnya, P. (2018). Hydroponics Technology for Horticultural Crops, Tech. Bull. TB-ICN 188/2018. Publ. by I.A.R.I., New Delhi-110012 INDIA.
- Misra S., Misra S., Misra R.L. (2017). Soilless Crop production. Daya PublishingHouse, Astral International (P) Ltd., New Delhi.
- Palaniappan S. P., Annadurai K. (2018). Organic Farming: Theory & Practice. Scientific Publisher.
- Goddek, S., Joyce, A., Kotzen, B., Burnell, G.M. (2019). Aquaponics FoodProduction Systems. Springer, Cham.

Suggestive readings

- Jones, J. B. (2014). Complete Guide for Growing Plants Hydroponically. CRCPress.
- Vayas, S.C, Vayas, S., Modi, H.A. (1998). Bio-fertilizers and organic Farming.Akta Prakashan, Nadiad.

GENERIC ELECTIVES (GE-4)

Credit distribution, Eligibility and Pre-requisites of the Course

Course t itle & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite o f the course
		Lecture	Tutorial	Practical/ Practice		
Basic Laboratory and Field Skills in Plant Biology	4	2		2	12^{th} Pass	**Nil**

Learning Objectives

The Learning Objectives of this course are as follows:
To learn fundamental skills important for performing laboratory and fieldexperiments.

Learning outcomes

After completion of this course the student will learn:

- Good Lab Practices, management of laboratory waste, understanding hazards andrisks to ensure a safe laboratory environment.
- Basics of measurements, units and common mathematical calculations, samplingand data collection.
- Handling and maintenance of instruments
- Presentation, analysis and interpretation of results.

SYLLABUS OF GE-4

Unit 1: Lab safety and good lab practices

Hours: 04

General laboratory safety, good laboratory practices, biosafety measures (first-aid practicesto be followed in case of burn, acid and injury), safety symbols, lab safety equipments (Fireextinguisher, fume hood, safety glasses), classes of laboratory chemicals, maintenance and handling of chemicals (Labels, Quality - LR/ AR/ Molecular biology grade/ HPLC grade; Expiry date; Precautions for use), Disinfectants, Biocontainment, Disposal of hazardous chemicals, radioactive and biological waste, Laboratory waste management

Unit 2: Use and maintenance of Laboratory equipments

Hours: 04

Weighing balance (Top loading and Analytical), pH meter (calibration and use), magnetic stirrer, pipettes, autoclave, laminar airflow, BOD incubator, incubator shaker, micrometer, haemocytometer, spectrophotometer, Agarose gel electrophoresis unit, SDS PAGE unit, centrifuge, distillation unit, conductivity meter, Lux meter.

Unit 3: Microscopy, sample and slide preparation:

Hours: 5

Microscopes (Dissecting, compound, electron microscope), Fixation and Preservation (for light and electron microscopy); staining, mounting; basic introduction to other types of microscopes (confocal, fluorescence)

Unit 4: Measurements and calculations

Hours: 02

Units of measurements and conversion from one unit to another, measurement of volumes of liquids, Weighing, calculations: scientific notations, powers, logarithmand fractions

Unit 5: Solutions and Buffers

Hours: 02

Molarity, Molality, Normality, percent solution, stock solution, standard solution, dilution, dilution series, pH, acid and bases, buffers- Phosphate, Tris- acetate, Tris-Cl and Citrate buffer

Unit 6: Basic culturing techniques

Hours: 03

Basic culture media (LB, YEB, MS)- Liquid and solid, Culture techniques : plating (streak, spread & pour),replica plating , serial dilution

Unit 7: Data collection, statistical analysis and interpretation

Hours: 04

Fundamentals of data collection, data types - primary and secondary, methods of data collection, sample, sampling methods - merits and demerits, technical and biological replicates, classification - tabulation and presentation of data, Descriptive statistics - Mean, mode, median, Variance, Standard Deviation, Standard error, Coefficient of Variation, difference between sample and population mean.

Unit 8: Basic computer skills for biology

Hours: 04

MS- Word, PowerPoint, Excel, introduction to biological databases

Unit 9: Field Skills

Hours: 02

Identification, collection, cataloguing and preservation of plant specimens, Herbariumand Museum

Practicals: (60 Hours)

1. Preparation of solution- molar, molal, normal, percentage, stock, standard and serial dilution
2. Determining pH of solutions (pH paper, Universal indicator, pH meter) and preparation of buffers (Phosphate, Tris-Cl, Electrophoresis buffers- TBE/TAE)
3. Working of instruments - light microscope, autoclave, laminar air flow, spectrophotometer, centrifuge, gel electrophoresis unit (Agarose & Poly acrylamide gels)
4. Temporary peel mount slide preparation and staining (safranin and acetocarmine).
5. Calculate cell size using micrometer.
6. To calculate number of cells using haemocytometer per unit volume (using pollen/spores)
7. Preparation of LB medium, growth and maintenance of bacterial cultures (liquid -serial dilution method; and semi-solid cultures - streak, spread and pour plates)
8. Isolation of genomic DNA from *E. coli* and plant leaf material, Agarose gel electrophoresis.
9. Calculation of mean, mode, median, standard deviation using data set (collected from experiments 5,6.
10. Using software to draw tables, graphs and calculating descriptive statistics (Microsoft Excel)
11. Laboratory safety equipments (Fire extinguisher, Fume hood, safety glasses)
12. Mounting of a properly dried and processed plant specimen with herbarium label

Essential/recommended readings

- Evert, R. F., Eichhorn, S. E., Perry, J.B. (2012). Laboratory Topics in Botany. W.H. Freeman and Company.
- Mesh, M.S., Kebede-Westhead, E. (2012). Essential Laboratory Skills for Biosciences. John Wiley & Sons, Ltd.
- Mu, P., Plummer, D. T. (2001). Introduction to practical biochemistry. TataMcGraw-Hill Education.
- Mann, S. P. (2016). Introductory Statistics, 9th edition. Hoboken, NJ, John Wiley and Sons Inc.
- Danniel, W.W. (1987). Biostatistics. New York, NY: John Wiley Sons.

- Jones, A., Reed, R.,Weyers, J. (2016) Practical Skills in Biology, 6th Edition, Pearson.

- Bisen, P.S. (2014). Laboratory Protocols in Applied Life Sciences (1st edition). CRC Press.

Suggestive readings

Zar, Z. H. (2010). Biostatistical Analysis, 5th edition, Pearson Prentice Hall, New Jersey, USA.

GENERIC ELECTIVES (GE-5)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Green Belt Development and Urban Management for Smart Cities	4	2		2	12th Pass	**Nil**

Learning Objectives

The Learning Objectives of this course are as follows:

- Green Belt Development is a major step in the development of a sustainable ecosystem, particularly under the Smart Cities Program for urban development (Government of India).
- To introduce students with one of the key green skill development programs under the Skill India mission by the Government of India.
- To acquaint students with various methods and techniques used in development of green infrastructure for smart cities

Learning outcomes

Students will gain as the:

- Course familiarizes students with green skills that contribute to preserving or restoring the environment for a sustainable future that protect ecosystems and biodiversity, reduce energy and minimize waste and pollution.
- This course will help students understand the role of green belt in capturing the

transient emissions, prevent soil erosion and degradation, containing water run- offs and recharging ground water, attenuate the noise generated and improve the aesthetics.

- Students would be well trained (knowledge & skills) to contribute to Green Sector Skill program.

SYLLABUS OF GE-5

Unit 1: Introduction

Hours: 02

Definition, History and Concept of Green Belt; Aesthetics and Importance; Recommended Guidelines for green belt development for industries; Advantages and Applications.

Unit 2: Pollution and Carbon emission

Hours: 04

Type and various source of Emissions; Methods of estimation and monitoring of pollutants; Mechanism of deposition; Regulatory standards for major pollutants.

Unit 3: Plant-Pollutant Interaction

Hours: 04

Methods of sampling and screening local flora, Native and Exotic Plants, Various indicators (Morphological, Anatomical, Physiological and Biochemical) for selection of pollution mitigating plants; Sensitive/indicator, Resistant/ Tolerant Plant Species for different pollutants (air, water, land and sound). Factors effecting plant regeneration and growth.

Unit 4: Structural and Functional Aspects of Green Belt

Hours: 06

Methods of Planting and Propagation, Various approaches for green belt development, Theoretical Models; Site specific ecological requirements, parameters involved that effect landscape design, Methods to evaluate the effectiveness of green belt. Various tools for assessment and monitoring of green belt (GIS and Remote Sensing)

Unit 5: Green Belt for Mitigating Climate change

Hours: 04

Objectives of UNFCCC for mitigating greenhouses gases in urban sectors, Green Finance and Green Infrastructure development, Methods to Evaluate total carbon sequestered; Carbon stocks and credits.

Unit 6: Waste water treatment through constructed wetlands

Hours: 06

Introduction: Wetlands values and functions, natural and constructed wetlands for wastewater treatments; Life forms in wetlands: microbes and vegetation in wetlands, plants adapted to pollutants and flooding, Role of macrophytes in constructed wetlands; physical and chemical characteristics of freshwater wetlands, constructed wetlands: types, role and management including key parameters for assessment.

Unit 7: Economics of Green Infrastructure

Hours: 04

Understanding of key plants for green economy - NFTP (Non-Forest timber products), biodiesel plants, herbal garden; Evaluating the cost and benefits of green belt development with type studies, Environmental accounting, Ecosystem services and constituents of wellbeing. Environmental Impact Assessment

Practicals: (60 Hours)

1. Methods of Vegetation Sampling and calculation of importance value index.
2. Measuring Tree Height and Cover to estimate green cover of an area.
3. Estimation of total carbon of an area.
4. Methods for selection of plants according to pollutant load both air and water (includes field survey)
5. Open Sources Software for mapping the GPS points and generating a cover map.
6. Measurement of Dissolved Oxygen (DO) from treated waste water.
7. Measurement of BOD and TDS from intake and treated pond.

Suggested Readings:

- Vesilind, P. A., Peirce, J. J., Weiner, R., (1998). Environmental Pollution and Control Netherlands: Elsevier Science.
- Burnwal, K., Jagwani, D. (2013). Air Pollution Abatement through Trees & Green Belt Development. LAP Lambert Academic Publishing.

- CPCB (2000). Guidelines for Green Belt development, CPCB, MoEF, GoI, New Delhi.
- Zhou, S. W. W., Zhou, S. W. W. (2020). Carbon Management for a Sustainable Environment. Germany: Springer International Publishing.
- Yunus, M., Singh, N. *de* Kok, L.J. (2013). Environmental Stress: Indication,Mitigation and Eco-conservation.Netherlands: Springer Netherlands
- Acar, S., Yeldan, A.E. (2019). Handbook of Green Economics Netherlands: Elsevier Science.
- Stefanakis, A., (2018). Constructed Wetlands for Industrial Wastewater Treatment United Kingdom, Wiley.
- Kröpfelová, L., Vymazal, J., Kröpfelová, L., Vymazal, J. (2008). Wastewater Treatment in Constructed Wetlands with Horizontal Sub-Surface Flow. Czechia: Springer Netherlands.

Suggestive readings

Amati, M. (2016). Urban Green Belts in the Twenty-first Century (Urban Planning and Environment) 1st Edition. Routledge publishers

Note: E xamination s cheme a nd m ode s hall b e a s p rescribed by t he E xamination Branch, University of Delhi, from time to time.

DEPARTMENT OF ZOOLOGY

BSC (Hons.) Zoology

Category-I

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Nonchordata – Protists to Pseudocoelomates	4	2	0	2	Class XII pass with Biology as one of the papers in Class XII	-

Learning Objectives

The course would provide an insight to the learner about the existence of different life forms on the earth and appreciate the diversity of animal life. It will help the students to understand the features of non-chordates and their systematic organization based on evolutionary relationships, structural and functional affinities. The course will also make the students aware about the characteristic morphological and anatomical features of diverse animals; the economic, ecological, and medical significance of various animals in human life; and will create interest among them to explore the animal diversity in nature.

Learning outcomes

Upon completion of the course, students should be able to:

- Learn about the importance of systematics, taxonomy, and structural organization of non-chordates.
- Appreciate the diversity of non-chordates living in varied habits and habitats
- Understand evolutionary history and relationships of different non-chordates through functional and structural affinities.
- Critically analyse the organization, complexity and characteristic features of nonchordates.
- Recognize the life functions and the ecological roles of the animals belonging to different phyla.
- Enhance collaborative learning and communication skills through practical sessions, teamwork, group discussions, assignments, and projects.

SYLLABUS OF DSC-1

Unit I: Introduction to Non-chordates (2 Hours)

General characteristics of non-chordates and basis of classification.

Unit II: Protista (07 Hours)

General characteristics and classification; Life cycle of *Plasmodium vivax;* Locomotion and reproduction in Protista.

Unit III: Porifera (05 Hours)

Introduction to Parazoa; General characteristics and classification; Canal system in sponges.

Unit IV: Cnidaria and Ctenophora (8 Hours)

Introduction to Metazoa; General characteristics and classification; Polymorphism in Cnidaria; Corals and coral reefs.

Unit V: Platyhelminthes and Nemathelminthes (8 Hours)

General characteristics and classification; Parasitic adaptations of Helminthes; Life cycle of *Taenia solium* and *Ascaris lumbricoides*.

Note: Outline classification up to classes to be followed from "Ruppert, Fox and Barnes (2004). Invertebrate Zoology: A Functional Evolutionary Approach". VII Edition, Cengage Learning, India

Practical component

1. Study of whole mount of Euglena, Amoeba, Noctiluca, Paramecium, Binary fission in Paramecium and Conjugation in Paramecium.
2. Examination of pond water collected from different places to observe diversity inProtista.
3. Study of Sycon, Hyalonema, Euplectella, Spongilla, T.S. of Sycon, L.S. of Sycon.
4. Study of *Obelia, Physalia, Millepora, Aurelia, Tubipora, Corallium, Alcyonium, Gorgonia, Metridium/Adamsia, Pennatula, Fungia, Meandrina, Madrepora.*
5. Specimen/slide of any one Ctenophore.
6. Study of adult *Fasciola hepatica, Taenia solium* and their life stages (Slides/microphotographs).
7. Study of adult *Ascaris lumbricoides* and its life stages (Slides/microphotographs).
8. To submit a Project Report on the life cycle of any one parasite or pathogen/corals/coral reefs.
9. Examination of soil samples collected from different places to observe diversity in nematodes.

Essential readings

1. Ruppert, Fox and Barnes (2004). Invertebrate Zoology. VII Edition, Cengage Learning, India.
2. Pechenik, J. A. (2015). Biology of the Invertebrates. VII Edition, McGraw-Hill Education.
3. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). The Invertebrates: A New Synthesis. III Edition, Blackwell Science.

DISCIPLINE SPECIFIC CORE COURSE – 2 (DSC-2) Biology of Cell: Structure

Credit distribution, Eligibility and Prerequisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Biology of Cell: Structure and Function	4	2	--	2	Class XII pass with Biology as one of the papers in Class XII	-

Learning Objectives

The objective of the course is to help the students to learn and develop an understanding of a cell as a basic unit of life. This course is designed to enable them to understand the functions of cellular organelles and how a cell carries out and regulates cellular functions.

Learning outcomes

Upon completion of the course, students should be able to:

- Understand the fundamental principles of cell biology.
- Explain the structure and functions of cell organelles involved in diverse cellular processes.
- Appreciate how cells grow, divide, survive, die, and regulate these important processes.
- Comprehend the process of cell signaling and its role in cellular functions.
- Have an insight into how defects in the functioning of cell organelles and regulation of cellular processes can develop into diseases. Learn the advances made in the field of cell biology and their applications

SYLLABUS OF DSC- 2

Unit I: Overview of Cells and Plasma membrane (05 Hours)

Prokaryotic and Eukaryotic cells; Various models of plasma membrane structures, Transport across membranes: active and passive transport, facilitated transport; Cell-cell junctions, structures, and functions: Tight junctions, adherens junctions, gap junctions.

Unit II: Endomembrane System (10 Hours)

Structure and Functions: Endoplasmic Reticulum (ER), Golgi apparatus, Signal hypothesis, Vesicular transport from ER to Golgi apparatus, Protein sorting and transport from Golgi apparatus, Coated Vesicles, Lysosomes, Peroxisomes. Structure of Mitochondria, Semiautonomous nature, Endosymbiotic hypothesis; Respiratory chain, Chemiosmotic hypothesis, ATP Synthase.

Unit III: Cytoskeleton (2 Hours)

Structure and Functions: Microtubules, Microfilaments and Intermediate filaments.

Unit IV: Nucleus (4 Hours)
Structure of Nucleus, Nuclear envelope, nuclear pore complex, Transport of molecules across nuclear membrane, nucleosome, nucleolus; Chromatin: euchromatin, heterochromatin.

Unit V: Cell Division (4 Hours)
Mitosis, Meiosis, Cell cycle and its regulation.

Unit VI: Introduction to Cell Signaling (05 Hours)
Cell Signaling through G-protein coupled receptor (GPCR) and role of secondary messenger: cAMP and protein kinase A.

Practical component (60 Hours)

1. Microscopy: Compound microscope: principle, components and handling; Phase contrast microscope; Electron microscope; Differential Interference Contrast (DIC) Microscope.
2. Principle and types of cell fixation and staining; Cell fractionation.
3. To study prokaryotic cells by Gram staining and eukaryotic cell (cheek cells) by hematoxylin/methylene blue.
4. To study the effect of hypotonic, isotonic, and hypertonic solutions on cell permeability.
5. Preparation of a temporary slide of squashed and stained onion root tip to study various stages of mitosis.
6. Study the effect of colchicine on mitosis at 24 hrs and 48 hrs.
7. Study of various stages of meiosis through permanent slides.
8. Preparation of stained mount to show the presence of Barr body in human female blood cells/cheek cells.
9. Cytochemical demonstration of:
    a. DNA by Feulgen reaction
    b. Mucopolysaccharides by PAS reaction
    c. Proteins by Mercuric Bromophenol Blue/Acid Fast Green

Essential readings

1. Cooper, G.M., Hausman, R.E. (2019) The Cell: A Molecular Approach. VIII Edition, ASM Press and Sinauer Associates.
2. Becker, Kleinsmith, and Hardin (2018) The World of the Cell, IX Edition, Benjamin Cummings Publishing, San Francisco.
3. Karp, G. (2015). Cell and Molecular Biology: Concepts and Experiments, VIII Edition, John Wiley & Sons Inc.
4. Renu Gupta, Seema Makhija and Ravi Toteja (2018). Cell Biology Practical Manual, Prestige Publishers, New Delhi
5. VK Sharma (1991). Techniques in Microscopy and Cell Biology, Tata McGraw-Hill Publishing Company Limited, New Delhi

DISCIPLINE SPECIFIC CORE COURSE– 3 (DSC-3) Concepts of Ecology

Credit distribution, Eligibility and Pre-requisites of the Course

Course	Credits	Credit distribution of the course	Eligibility	Pre-requisite

title & Code		Lecture	Tutorial	Practical/ Practice	criteria	of the course(if any)
Concept of Ecology	**4**	**2**	**0**	**2**	**Class XII pass with Biology as one of the papers in Class XII**	**NIL**

Learning Objectives

The primary aim of this course is to develop a scientific understanding of the diverse aspects of the field of ecology. The students will be familiarized with the interactions between the organisms and their physical environment. Additionally, various attributes of populations and communities with help of theoretical concepts and field examples will be discussed. It provides a platform to understand the varied forces that lead to variations among populations of a species.

Learning outcomes

Upon completion of the course, the students should be able to:

- Demonstrate an understanding of the basic concepts of the subject
- Explain the characteristics, dynamics, and growth of populations
- Understand the characteristics of the community, ecosystem development and climax theories
- Gain knowledge about the relationship of the evolution of various species and the
- environment they live in.
- Design basic field studies, collect data and interpret it
- Carry out population and community studies

SYLLABUS OF DSC-3

Unit I: Introduction to Ecology (03 Hours)
Autecology and Synecology, Laws of limiting factors, Study of physical factors: Temperature and Light.

Unit II: Population (07 Hours)
Unitary and Modular populations; Unique and group attributes of population: density, natality, mortality, life tables, fecundity tables, survivorship curves, age ratio, sex ratio, dispersal and dispersion; Exponential and logistic growth, equations and patterns, *r* and *k* strategies; Intraspecific population regulation: density-dependent and independent factors.

Unit III: Species Interactions (06 Hours)
Types of species interactions, Interspecific competition: Lotka-Volterra model of competition, Gause's Principle with laboratory and field examples, Niche concept; Predation: Lotka-Volterra equations, Functional and numerical responses, predator defence mechanisms, Resource partitioning.

Unit IV: Community (05 Hours)

Community characteristics: species richness, dominance, diversity, abundance, guilds, ecotone and edge effect; Ecological succession with examples and types.

Unit V: Ecosystem (6 Hours)
Types of Ecosystems: Terrestrial ecosystem, vertical stratification in tropical forest; Food chain: detritus and grazing food chains, linear and Y-shaped food chains, food web; Energy flow through the ecosystem; Ecological pyramids and Ecological efficiencies; Biogeochemical cycle- nitrogen cycle.

Unit VI: Applied Ecology (03 Hours)
Ecology in wildlife conservation and management, Protected areas: National Parks, Biosphere reserves and Sanctuaries; Restoration ecology, Principles of Environmental impact assessment.

Practical components (60 Hours)

1. Study of life tables and plotting of survivorship curves of different types from hypothetical/ real data
2. Determination of population density in a natural or a hypothetical community by quadrate method and calculation of Shannon-Weiner diversity index.
3. Study of an aquatic ecosystem:
   a) Phytoplankton and zooplankton
   b) Measurement of temperature, turbidity/penetration of light, determination of pH
   c) Dissolved oxygen content (Winkler's method), chemical oxygen demand
   d) Free carbon dioxide and alkalinity
4. Study of ten endemic animals of India with slides/pictures/videos.
5. Report on a visit to a National Park/Biodiversity Park/Wildlife Sanctuary.

Essential readings
1. Odum, E.P. and Barrett G. W. (2008). Fundamentals of Ecology. Indian Edition (5th).Publisher: Brooks/Cole.
2. Smith T. M. and Smith R. L. (2015). Elements of Ecology. 9th International Edition. Publisher: Benjamin Cummings.
3. Saha G.K. and Mazumdar S. (2020) Wildlife Biology, An Indian Perspective. Publisher: PHI Learning Private Limited
4. Zimmer C. and Emlen D. J., (2013) 1st Edition. Evolution: Making Sense of Life, Roberts & Co.
5. Futuyma, Douglas and Mark, Kirkpatrick (2017) 3rd Edition. Evolutionary Biology, Oxford University Press

Note: Examination s cheme a nd m ode s hall be a s pr escribed by t he E xamination Branch, University of Delhi, from time to time

COMMON POOL OF GENERIC ELECTIVES (GE) COURSES
Offered by Department of Zoology
Category-IV

GENERIC ELECTIVES (GE-1): Human Physiology

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course	Department offering the course
		Lecture	Tutorial	Practical/ Practice			
Human Physiology	4	2	-	2	12th Pass	Nil	Zoology

Learning Objectives

This course offers an overview of the concepts of normal biological functions in the human body. The fundamentals of human physiology and histological structures will be correlated. The concept of homeostasis in response to changes in the external environment will be introduced. Further, students will be provided with knowledge that can be applied in everyday life. The students will be encouraged to pursue further studies in physiology and related fields as well as multidisciplinary subjects that require an understanding of the physiology of humans.

Learning outcomes

Upon completion of the course, students will be able to:

- Understand the principles of normal biological function in the human body.
- Outline basic human physiology and correlate it with histological structures.
- Understand the homeostasis in animals in response to changes in their external environment.

SYLLABUS OF GE-1

Unit I: Tissues (05 Hours)
Types of Tissues; Structure and Function of Epithelial, Connective, Muscular and Nervous tissues.

Unit II: Functioning of Excitable Tissue (Nerve and Muscle) (05 Hours)
Propagation of nerve impulse (myelinated and non-myelinated nerve fibre); Mechanism of muscle contraction (Sliding filament theory).

Unit III: Digestion and Absorption of Food (05 Hours)
Structure and function of digestive system; Digestion and absorption of carbohydrates, fats and proteins.

Unit IV: Respiratory Physiology (04 Hours)

Structure and function of respiratory tract and lungs; Ventilation, External and Internal respiration; Transport of oxygen and carbon dioxide in blood.

Unit V: Cardiovascular System (04 Hours)
Structure of heart, Cardiac cycle, Composition of blood

Unit VI: Renal Physiology (03 Hours)
Functional anatomy of kidney

Unit VII: Reproductive Physiology (04 Hours)
Structure of testis and ovary; Spermatogenesis and Oogenesis.

Practical component (if any) (60 Hours)
1. Preparation of temporary mount of neurons and blood cells (blood film preparation).
2. Preparation of haemin and haemochromogen crystals.
3. Haemoglobin estimation using Sahli's haemoglobinometer.
4. Determination of ABO Blood group.
5. Recording of blood pressure using a Sphygmomanometer.
6. Examination and detailed study of permanent histological sections of mammalian Stomach, Duodenum, Liver, Lung, Kidney, Pancreas, Testis and Ovary.

Essential readings
1. Tortora, G.J. and Derrickson, B.H. (2012). Principles of Anatomy and Physiology. XIIIth Edition, John Wiley and Sons, Inc.
2. Widmaier E, Raff H and Strang K. (2013). Vander's Human Physiology: The Mechanism of Body Functions. XIIIth Edition, McGraw-Hill Education.
3. Guyton, A.C. and Hall, J.E. (2011) Textbook of Medical Physiology. XII Edition, Harcourt Asia Pvt. Ltd/ W.B. Saunders Company.
4. Kesar, S. and Vashisht, N. (2007) Experimental Physiology. Heritage Publishers.
5. Prakash, G. (2012) Lab Manual on Blood Analysis and Medical Diagnostics. S. Chand and Company Ltd.

GENERIC ELECTIVES (GE-2): Nature and Wildlife Studies

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course	Department offering the course
		Lecture	Tutorial	Practical/ Practice			
Nature and Wildlife Studies	4	2	-	2	12th Pass	Nil	Zoology

Learning Objectives

The course is designed to acquaint students with varied aspects of wildlife conservation, including its importance, major threats, and management of habitats and populations. The emphasis will be on developing interest and invoking a sense of responsibility among students towards wildlife conservation. The course also explores different techniques, perspectives, and approaches to both identify and achieve wildlife management goals. Further, students will be motivated to pursue careers in the field of wildlife conservation and management..

Learning outcomes

By studying the course the students will develop:

- Understanding about wild life
- Evaluation and Management of Wildlife
- Wild life resources and protection

SYLLABUS OF GE-2

Unit I: Conservation of Nature and Wildlife (06 Hours)
Values of wildlife - positive and negative; Conservation ethics; Importance of conservation; Causes of depletion; World conservation strategies: Wildlife Conservation Society (WCS), Convention on Biological Diversity (CBD), Agenda 21 of United Nations.

Unit II: Evaluation and Management of Wildlife (06 Hours)
Habitat analysis: a) Physical parameters: Topography, Geology, Soil and water; b) Biological Parameters: food, cover, forage; Census method

Unit III: Management of Natural Habitats (04 Hours)
Setting back succession: Grazing logging, Mechanical treatment, Advancing the successional process.

Unit IV: Management Planning of Wildlife in Protected Areas (04 Hours)
Human-wildlife conflict, Captive Breeding, Ecotourism.

Unit V: Wildlife Health and Management (04 Hours)
Care of injured and diseased animals, Quarantine; Zoonotic diseases: Ebola, Salmonellosis, Rabies, Foot and Mouth Disease, MonkeyPox, SARS, Bovine and Avian Flu.

Unit VI: Protected Areas (06 Hours)
National parks and sanctuaries, Biosphere reserves, Conservation and Community reserve, Important features of protected areas in India, Tiger conservation , management and challenges.

Practical component (if any) (60 Hours)

1. Identification of mammalian fauna, avian fauna, herpeto-fauna through direct and indirect evidences seen on a field trip to a wildlife conservation site.
2. Demonstration of basic equipment needed in wildlife studies use, care and maintenance (Compass, Binoculars, Spotting scope, Range Finders, Various types of Cameras and lenses).
3. Familiarization and study of animal evidences in the field: Identification of animals
4. through pug marks, hoof marks and scats.

5. To study the various animal tracking system: Global Positioning System, Remote Sensing and Biotelemetry.
6. Trail / transect monitoring for abundance and diversity estimation of mammals and bird (direct and indirect evidences).
7. A report based on a visit to National Park/ Wildlife Sanctuary/ Biodiversity Park or any other wildlife conservation site.

Essential readings

1. Saha, G.K. and Mazumdar, S. (2017). Wildlife Biology: An Indian Perspective. PHI learning Pvt. Ltd. ISBN: 8120353137, 978-812035313
2. A.R.E. Sinclair, J.M. Fryxell and G. Caughley (2006). Wildlife Ecology, Conservation and Management. Wiley-Blackwell, Oxford, UK.
3. S.K. Singh (2005). Textbook of Wildlife Management. IBDC, Lucknow.
4. K. Banerjee (2002). Biodiversity conservation in managed and protected areas. Agrobios, India.
5. B.D. Sharma (1999). Indian Wildlife Resources Ecology and Development. Daya Publishing House, Delhi.
6. R.B. Primack (1998). Essentials of Conservation Biology. Sinauer Associates, Inc. Sunderland, MA.
7. B. B. Hossetti (1997). Concepts in Wildlife Management. Daya Publishing House, Delhi.

ACBR

BSc (H) Biomedical Science
Category-I

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course t itle & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite o f the course (if any)
		Lecture	Tutorial	Practical/ Practice		
BIOORGANIC CHEMISTRY	**4**	**3**	**-**	**1**	**Student should have studied science (Biological science/ physical sciences)**	**-**

Learning Objectives

The Learning Objectives of this course are as follows:
Bioorganic Chemistry is a discipline that integrates organic chemistry and biochemistry. It aims at understanding the relevance of biological processes using the fundamental concepts of organic chemistry. This course includes basic principles of organic chemistry like concepts of stereochemistry and their importance in understanding various bio-molecular reactions along with introduction to biomolecules.

Learning outcomes

The Learning Outcomes of this course are as follows:
The students will be able:

- Identify, assess and analyze different types of stereoisomers and their properties in organic compounds and biomolecules.
- Explain the structures and function of biomolecules (carbohydrates, amino acids, lipids and nucleotide.
- To understand the mechanism of biologically significant name reaction and their role in biological systems.

SYLLABUS OF DSC-1

UNIT – I Stereochemistry (9 Hours)

Optical isomerism: Optical activity, specific rotation, enantiomerism, D and L designation, racemic modification, R and S sequence rules, diastereoisomers.
Conformational isomers: conformation of ethane and butane, interconversion of projection formula, cyclohexane (mono- and di-substituted), resolution, optical purity.

Geometrical isomerism: Definition, nomenclature– E and Z.

UNIT – II Introduction to Biomolecules I (12 Hours)

Carbohydrates:

Monosaccharides- cyclization of aldoses and ketoses, conformations, concept of mutarotation, anomers, epimers.

Disaccharides- structure, reducing and non-reducing sugars. Polysaccharides- Starch, glycogen and cellulose.

Lipids:

Fatty acids, triacylglycerols, phospholipids, lipid bilayer formation, steroids (cholesterol)

UNIT – III Introduction to Biomolecules II (12 Hours)

Amino Acids:

Structure and classification of amino acids, ionization, chemistry of peptide bond, non-ribosomal peptide bond formation, essential and non-essential amino acids, amino acids as precursors of other bioactive compounds, zwitterion, isoelectric point, optical properties of amino acids, Definition of a peptide, peptide unit, peptide group, bond length, cis and transconformation, primary, secondary (alpha helix, beta sheet, beta turn, collagen helix), tertiary and quaternary structures (with examples).

Nucleotides:

Sugars and Bases, conformation of sugar phosphate backbone, hydrogen bonding and tautomerism in nucleic acid basesEffect of structure on reactivity of biomolecules.

UNIT – IV Biologically Significant Name Reactions (12 Hours)

Aldol (Glucogenesis), retro-aldol (Glycolysis), benzoin condensation (umpolungdecarboxylation of pyruvate in the presence of TPP), Claisen condensation (synthesis of fatty acids), Michael addition (Dehydrases), Cannizzaro (Sugarmetabolism), Bayer Villiger reaction (FAD dependent ketone synthesis), Pinacol-pinacolone rearrangement (1,2-carboncarbonshift)

Practical component (12 Sessions x 2 hrs) – 30 Hours

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Qualitative tests for carbohydrates to identify the given unknown carbohydrate solution: Mohlisch, Barfoed, Fehling/ Tollen/ Benedict tests
2. Qualitative tests for carbohydrates toidentify the given unknown carbohydrate solution: Iodine test, Selvinoff, Osazone, Bial's tests
3. Qualitative tests for Amino acids and Proteins: Ninhydrin, Xanthoproteic, Million's, Lead Acetate, Biuret test
4. Qualitative test for Fats
5. Todetermine the Iodine number of the given oil/fat.
6. Tofind pKa value of acetic acid
7. To study the titration curve of glycine
8. Absorption spectrum of Protein
9. Absorption spectrum of DNA
10. Estimation of a Reducing sugar in a given sample.

Essential readings

1. Berg, J. M., Tymoczko J. L. and Stryer L. (2019) 9th Edition, International edition
2. Biochemistry. New York, USA: W. H. Freeman and Co. ISBN-9781319114671
3. Campbell, M. K. and Farrel, S. O. (2012) 7th Edition. Biochemistry. Boston, USA:Brooks/Cole Cengage Learning. ISBN: 13:978-1-111-42564-7
4. Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New York), ISBN:978-0-470-28173-4
5. Morrison, R.N., Boyd, R.N., Bhattacharjee, S.K. (2010), Organic Chemistry, 7th Edition,
6. Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). ISBN 10:8131704815 ISBN 13:9788131704813
7. Eliel, L. (1975). 1st Edition. Stereochemistry of carbon compounds, New York, USA: Tata McGraw Hill. ISBN-13: 9780070992900
8. Finar, I.L. (2002), Organic Chemistry (Volume 1), 6th Edition, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). ISBN-13: 978-0582305601
9. Dugas, H. (1999) 3rd Edition. Bioorganic chemistry. New York, USA: Springer Verlag. ISBN-13: 978- 0387989105

Suggestive readings:

- Nelson, D. L. and Michael M. Cox (2021) 8th Edition. Lehninger Principles of Biochemistry. New Jersey, USA: Prentice Hall Publishers. ISBN-13:978-1319228002.
- Nasipuri, D. (2020), Stereochemistry of Organic Compounds: Principles and Applications, 4 th Edition, New Age International. ISBN 10: 9389802474
- Solomons, T. W. G.; Fryhle, C. B.; Snyder, S. A. (2017), Organic Chemistry, 12th
- Edition, Wiley. ISBN: 978-1-119-24897-2
- Plummer, D. (2017) An Introduction to Practical Biochemistry, 3rd edition. McGraw-Hill College; ISBN-13: 978-0070841659.
- Hoffman, A. 8th Edition (2018). Wilson And Walker's Principles and Techniques of
- Biochemistry and Molecular Biology. Cambridge: Cambridge University Press. ISBN13: 9781316677056

DISCIPLINE SPECIFIC CORE COURSE – 2 (DSC-2): CELL BIOLOGY

Credit distribution, Eligibility and Prerequisites of the Course

Course t itle & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite o f the course (if any)
		Lecture	Tutorial	Practical/ Practice		
CELL BIOLOGY	**4**	**3**	**-**	**1**	**Student should have studied science (Biological science/ physical sciences)**	**-**

Learning Objectives

The Learning Objectives of this course are as follows:
Structure and functions of various cellular compartments and organelles

- Fundamentals of transport of biomolecules inside the cell and its cytoskeleton
- Cell growth, cell-division and cell-cycle control mechanisms.
- Cell to cell communication and participation of signal transduction pathways, in driving cell response mechanics

Learning outcomes

The Learning Outcomes of this course are as follows:

- Students will learn about how the cell has evolved and the basic types of cells present.
- Students will acquire insights into the composition and structure of cell membrane by navigating through various proposed cell models. Students will also learn the functions in detail about the processes of transport across cell membranes.
- Students will learn about the structure and function of various cellular compartments and organelles along with the concept of protein sorting and distribution in unique ways.
- Students will understand the association between cells through unique types of communication and developing junctions for attachment between neighbouring cells.
- Students will understand various cytoskeleton elements and their participation in maintaining cell shape and integrity. Students will gain knowledge about an overview of cell response to its environment, and involvement of cell- cell signalling mechanisms and to study signal transduction pathways.

SYLLABUS OF DSC- 2

UNIT – I The Cell (3 Hours)
Historical background, significant landmarks, cell theory, structure of prokaryotic and eukaryotic cells

UNIT – II Cell Membrane and Membrane Transport (6 Hours)
Functions, different models of membrane structure, types of membrane lipids, membrane proteins: types, methods to study membrane proteins (detergents, RBC ghosts), RBC membrane as a model, membrane carbohydrates, membrane asymmetry and fluidity, lipid rafts.
A. Transport of small molecules: Passive transport (simple diffusion and facilitated diffusion) and active transport and their types (P, V, F and ABC transporter) with example of Na+/K+ pump.
B. Transport of macromolecules: Endocytosis (pinocytosis, phagocytosis), exocytosis

UNIT – III Cell Organelles (15 Hours)
Structure and functions of various organelles:

- Nucleus: Different components, nuclear envelope- its structure, pore complex, nucleocytoplasmic, interaction (NLS and NES), nucleolus- structure and functions.
- Endoplasmic reticulum: RER- Biosynthesis and processing of proteins, co-translational and post-translational transport of proteins, signal hypothesis, protein sorting. SER- detoxification, biosynthesis of membrane, carbohydrate metabolism, steroid synthesis.
- Golgi apparatus: Golgi stack (cis, trans and medial cisternae), flow of proteins through Golgi body, glycosylation and protein sorting.

- Lysosomes: Development of different forms of lysosomes, role in cellular digestion, lysosomal storage diseases- Hurler syndrome, Hunter syndrome, Tay-Sachs disease and Inclusion cell disease (I-cell disease).
- Peroxisomes: Assembly, functions- H2O2 metabolism, oxidation of Fatty acids, glyoxysomes
- Mitochondria: Detailed structure, endosymbiotic theory, its genome and functions in brief
- Chloroplast: Detailed structure, its genome and functions in brief

UNIT – IV Cell -Cell communication (9 Hours)

Structures and functions of different types of anchoring junctions (desmosomes and hemidesmosomes), tight junctions, and communication junctions (gap junction and plasmodesmata).

UNIT – V Cytoskeletal Elements (6 Hours)

Structure, assembly and functions of:

A. Microtubules: Axonemal and cytoplasmic microtubules (cilia, flagella, centrioles, basal bodies).
B. Microfilaments: Globular and filamentous actin, general idea about myosin.
C. Intermediate filaments: Different classes.

Unit VI: Cell Signaling and Cell Cycle (6 Hours)

Signaling molecules and their receptors (extracellular and intracellular), functions of extracellular receptors; Intracellular signal transduction pathways (cAMP, cGMP, steroid hormone response element). Different phases of cell cycle and their significance, mitosis and meiosis, checkpoints and regulation of cell cycle.

Practical component (30 Hours)

(Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Light microscopy: Principle, construction and types. Study of positive and negative staining using photomicrographs.
2. Fluorescence microscopy: principle and applications. Concept of GFP
3. Electron microscopy: Principle, construction and types. Study of positive and negative staining, freeze fracture, freeze etching, shadow casting, endocytosis, exocytosis and phagocytosis using electron micrographs
4. To explain mitosis and meiosis using permanent slides.
5. To measure cell size using a stage micrometer.
6. To cytochemically demonstrate presence of total and basic proteins in cheek cells or onion peel using mercuric bromophenol blue or fast green.
7. To cytochemically demonstrate presence of carbohydrates in cheek cells or onion peel using periodic acid Schiff's reagent.
8. To cytochemically demonstrate presence of DNA in cheek cells or onion peel using Feulgen reagent.
9. To study the effect of isotonic, hypotonic and hypertonic solutions on cell.

Essential readings

- Cooper, G. M. and Hausman, R. E. (2013). 6th Edition. The cell: A molecular approach. Massachusetts, USA: Sinauer Associates. ISBN-13:978-1605351551

- Hardin, J. Bertoni, G. P. Kleinsmith, L.J. and Becker, W.M. (2008). 7th Edition. The world of the cell. San Francisco, USA: Benjamin Cummings Publishers, ISBN-13: 978 0805393934.
- Karp, G. (2013). 7th Edition. Cell and molecular biology: Concepts and experiments. New Jersey, USA: Wiley Publishers. ISBN-978-0470483374.
- Alberts, B et al. (2014). 6th edition. Molecular Biology of the Cell. W. W. Norton & Company. ISBN-13 : 978-0815345244
- Lodish H et al. (2003). 5th Revised edition. Molecular Cell Biology. W.H.Freeman & Co Ltd; ISBN13 : 978-0716743668

Suggestive readings

- Cooper, G. M. (2018). 8th Edition. The cell: A molecular approach. Massachusetts, USA: Sinauer Associates. ISBN-13:978-1605357072
- Hardin, J. Bertoni, G. P. Kleinsmith, L.J. and Becker, W.M. (2016). 9th Edition. The world of the cell. San Francisco, USA: Benjamin Cummings Publishers, ISBN-13: 978 -0321934925.
- Karp, G. (2019). 9th Edition. Cell and molecular biology: New Jersey, USA: Wiley Publishers. ISBN-978—1-119-59816-9.

DISCIPLINE SPECIFIC CORE COURSE– 3 (DSC-3): HUMAN PHYSIOLOGY

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
HUMAN PHYSIOLOGY AND ANATOMY-I	**4**	**3**	**-**	**1**	**Student should have studied science (Biological science/ physical sciences)**	

Learning Objectives

The Learning Objectives of this course are as follows:

- The course curriculum is a systematic presentation of physiological concepts to ensure appropriate depth and breadth of basic functioning of the human body and its interrelations with respect to heart, lung, kidney, gonads, endocrine glands and digestive system.
- It would give students exposure of physiological concepts needed as foundations for further studies in pharmacology, pathology and pathophysiology etc.
- It would provide a base to understand body defenses and the mechanisms of deranged function of human body
- The curricular objectives are focused primarily on normal body function. Accordingly, wherever possible clinical examples have been illustrated to the underlying physiological

principles.

Learning outcomes

The Learning Outcomes of this course are as follows:
Having successfully completed this course, students shall be able to learn and appreciate:

- The usefulness of dividing the human body in different anatomical planes and sections, cavities, along with the role of feedback system in maintaining homeostasis. Functional anatomy of the epithelial and connective tissues while focusing on integumentary and skeletal system. Overview of structure, types and function of cartilage, bone and joints.
- Structure, function and regulation of components/different formed elements of blood and the mechanism of clotting. Students would be able to understand different blood groups, basis of their classification, their importance in blood transfusions and tissue grafting and basic concepts of blood and bleeding disorders
- Student would be able to understand neurons their role and significance and how as a part of the brain they help in brain physiology. Appreciation of basic concepts of action potential/ graded potential in the conduction of nerve impulse. Action and significance of different neurotransmitters at the synapse along with the mechanism of synaptic transmission using different ligand gated ion channels, G protein coupled receptors and their ligands as example.
- Students would learn organization of brain, with identification of structures and function of different brain regions. Identify different neural pathways and explain their significance. They would understand the innate responses and conditioned response of day today life by studying autonomic nervous system and effect of its stimulation on different organs.
- The five senses which help an individual to perceive the world would be studied in detail. Stimulus modality, sensory adaptation and the role of generator potential in the sensory physiology of touch, gustation, olfaction, hearing and vision. They would recognize and explain the common disorders related to the senses.
- Students would be able to describe and distinguish between the structure, mechanism and regulation of contraction of skeletal, cardiac and smooth muscles. Enlist the energy requirements, characteristic features of different muscle fibers and their role in generating muscle tension. Demonstrate the concept of muscle fatigue, adaptation to physical training, and muscle degeneration and associated disorders.

SYLLABUS OF DSC-3

UNIT – I Body organization and Integumentary system (6 Hours)
General Anatomy of the body, Introduction to various kinds of body planes, cavities and their membranes, Tissues level of organization (Types, origin, function & repair). Structure and functions of human skin.
UNIT – II Blood (6 Hours)
Composition and Function of Blood and its components (RBC, WBC, platelets and plasma). Hematopoiesis, Hemoglobin structure, function and abnormal hemoglobin. Basic concepts about Anemia and types. Blood Hemostasis (blood coagulation/ clotting, platelet function and role of endothelium).

UNIT – III Nerve physiology (6 Hours)

Structure, function and types of neuron, conduction of nerve impulse, Resting membrane potential, Action and graded potential. Synapse its types, Synaptic Transmission, Neurotransmitters and their receptors; types and function

UNIT – IV Nervous System I: Organization of nervous system (6 Hours)

Structure, function and organization of Central nervous system, Peripheral nervous system and Autonomic nervous system. Motor physiology: Reflexes, types and reflex arch

UNIT – V Nervous System II: Sensory Physiology (6 Hours)

Concept of receptors in the body and their types, structure, functional anatomy, regulation and common disorders of the following sensations: Vision, Hearing, Taste, Smell and other senses (Touch, Pain, Temp).

UNIT – VI Muscular system (9 Hours)

Functional anatomy of muscular system, types of muscles, neuromuscular junction structure property and transmission, General characteristics, molecular mechanism and properties of skeletal muscle excitation and contraction, energetics and characteristics of whole muscle contraction.

Unit- VII Skeletal System (6 Hours)

Cartilage: structure, types and function. Bones: structure, function, location and types.
Joints: structure, function and types

Practical components (30 Hours)

(Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Estimation of haemoglobin (Sahli's method)
2. Determination of total erythrocyte count.
3. Determination of total leukocyte count.
4. Preparation of blood smears and identifying various WBC
5. To perform differential leukocyte count of blood.
6. To study a simple reflex arc
7. To study the sensation of taste, touch and smell.
8. To study different human organs and their sections through permanent histological slides T.S. of brain, spinal cord, skeletal fibres, cardiac muscles, skeletal muscles, cartilage joints and different tissues. (Minimum 8 slides covering the systems mentioned in theory.)

Essential readings

- Guyton and Hall Textbook of Medical Physiology, 12th edition (2011), J. E. Hall; W B Saunders and Company, ISBN: 978-1-4160-4574-8 International Edition: 978-08089-2400-5
- Human Physiology, 12thedition (2011), Stuart I. Fox; Tata McGraw Hill, ISBN 978007–337811–4MHID 0–07–337811–9.

Suggestive readings

- Principles of Anatomy and Physiology, 16th edition (2020), Gerard J. Tortora and Bryan H. Derrickson; Wiley and Sons, ISBN: 978-1-119-66268-6.(e book),ISBN: 978-1-119-70438-6 (for print book).

- Ganong'sReviewofMedicalphysiology,26thedition(2019),K.E.Barett,S.M.Barman,S. Boitano and H. Brooks; Tata McGraw Hill, ISBN 978-1-260-12240-4 (for print book) ISBN: 978-1-26-012241-1(for eBook)
- Textbook of Practical Physiology, 9th edition (2018), CL Ghai; Jaypee Publication, ISBN13: 978-9352705320 ISBN-10: 9352705327

Common Pool of Generic Electives (GE) Courses Offered by ACBR

Category-IV

Note: Examination s cheme a nd m ode s hall be a s pr escribed by t he E xamination Branch, University of Delhi, from time to time.

GENERIC ELECTIVES (GE-1): CONCEPTS IN BIOTECHNOLOGY

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisit e o f t he course
		Lecture	Tutorial	Practical / Practice		
CONCEPTS IN BIOTECHNOLOGY	4	3	-	1	The student should have studied science (Biological science/physical sciences)	NA

Learning Objectives

The Learning Objectives of this course are as follows:
The purpose of this course is to introduce students to importance of Biotechnology in allied fields. It will enable students from diverse backgrounds to understand basic concepts in Gene Cloning and DNA Analysis, and appreciate applications of Biotechnology in everyday life. The course will provide students with an insight into the various molecular biology techniques commonly used in Biotechnology, and some of the relevant bio-safety issues and ethical concerns.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Learn about basic biotechnology techniques and key concepts that are used in isolation and characterization of biomolecules (DNA and proteins).
- Develop basic understanding of the robust techniques with wide applications (such as PCR, DNA sequencing) and appreciate their contribution in development of biotechnology.
- Comprehend the importance of gene cloning in biotechnology and learn the intricacies of gene cloning using plasmids and bacteriophages as cloning vectors.

- Understand the importance of construction of genomic libraries and their specialized screening methods to identify gene of interest.
- Learn the concept and application of DNA fingerprinting, recombinant protein expression, biopharmaceutical protein production, and gene therapy.
- Gain an insight of safe handling of GMO's, their environmental release and ethical practices.

SYLLABUS OF GE-1

UNIT – I Techniques Used in Biotechnology (12 Hours)

Brief history of biotechnology and its importance. Isolation and purification of plasmid DNA. Agarose and Polyacrylamide gel electrophoresis (Native and SDS). Southern and Western hybridization. Polymerase Chain Reaction (PCR): Principle, DNA polymerases in PCR, Primer Designing, Types of PCR - Hot Start, Multiplex and Reverse Transcription and their Applications. Sequencing: Enzymatic (Sanger's dideoxy) method, Introduction to Automated Sequencing.

UNIT – II Process of Gene Cloning, Expression and Protein Purification (15 Hours)

Restriction endonucleases: Restriction and Modification Systems, Nomenclature and Types of Restriction Enzymes (Type I-IV), Recognition of Restriction Sites. Joining of DNA Molecules: Sticky End and Blunt End Ligations, Role of DNA Ligase, Adaptors, Linkers, Homopolymer Tailing. Vectors: Plasmids (pUC Vectors), Bacteriophage (Lambda Phage Derived Replacement And Insertion Vectors), Cosmids, In Vitro Packaging, Expression Vectors (One example each of prokaryotic and eukaryotic expression vectors). Bacterial Transformation, Antibiotic Selection and Blue/White Screening of Transformants. Challenges in Expression of Eukaryotic Proteins in Prokaryotic Hosts

UNIT – III Genomic and cDNA Libraries (18 Hours)

Construction of Genomic and cDNA Libraries, their Screening by Nucleic Acid Hybridization (Colony and Plaque Hybridization).

UNIT – IV Applications of Biotechnology (6 Hours)

DNA Fingerprinting. Using the Example of Human Insulin learn the Importance of Various Applications of Biotechnology: Recombinant Protein Expression, Biopharmaceutical Protein Production and Gene Therapy.

UNIT – V Biosafety and Ethical Issues (6 Hours)

Safe Handling and Disposal of GMOs and Relevant Ethical Issues. Impact of GMOs on the Environment (Bt. Toxin).

Practical component- (12 Sessions x 2 = 24 hrs)

(Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. To prepare laboratory reagents.
2. To perform plasmid DNA isolation.
3. To perform agarose gel electrophoresis of isolated plasmid DNA.
4. To perform restriction digestion of plasmid DNA.
5. To perform agarose gel electrophoresis of digested DNA.
6. To study restriction mapping.
7. To amplify DNA using PCR.
8. To perform agarose gel electrophoresis of amplified DNA

Essential readings

- Cantor, C. R. and Smith, C. L. (2004). 1st Edition. Genomics: The science and technology behind the human genome project. New York, USA: John Wiley and Sons. ISBN-13: 978-0471461869.
- Old, R. W. and Primrose, S. B. (1994). 7th Edition. Principles of Gene Manipulation: an Introduction to Genetic Engineering. Boston: Wiley. ISBN-13: 978-0632037124.
- Joseph Sambrook, E.F. Fritsch, T. Maniatis. (1989). 2nd Edition. Molecular Cloning: A Laboratory Manual. New York, USA: Cold Spring Harbor Laboratory. Press ISBN- 978-0879693732.

Suggestive readings

- Glick, B. R. and Patten, C. L. (2022). 6thEdition. Molecular Biotechnology: Principles and Applications of Recombinant DNA. USA: ASM press, ISBN-13: 978-1683673668.
- Brown, T. A. (2020). 8thEdition. Gene cloning and DNA analysis: An introduction. New York, USA: John Wiley and Sons, ISBN-13: 978-1119640783.
- Karp, G. (2016). 8th Edition. Cell and Molecular Biology: Concepts and Experiments. United states: Wiley. ISBN-13: 9781538832462.
- Primrose, S. B. and Twyman, R. B. (2014). 7th Edition. Principles of Gene Manipulation and Genomics. New York, USA: John Wiley and Sons. ISBN-13: 978-1118653883.
- Green, M. R. and Sambrook, J. (2012). 4th Edition. Molecular Cloning: A Laboratory Manual (three-volume set). New York, USA: Cold Spring Harbor Laboratory Press ISBN-13: 978- 1936113422

GENERIC ELECTIVES (GE-2): LANDMARK DISCOVERIES IN SCIENCE

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
LANDMARK DISCOVERIES IN SCIENCE	4	3	-	1	The student should have studied science (Biological science/physical sciences)	NA

Learning Objectives

The Learning Objectives of this course are as follows:
The objective of the course is to ensure students appreciate the convenience and comfort that they have is all because of discoveries and inventions of the past. Meticulous execution of historical experiments in very little resources would also motivate them towards doing valuable research with enormous facilities that they have. The historical accounts of science provide grounds for interpretation and may be useful in arousing appreciation of science. The course would provide: Detailed analysis of classically designed and executed experiments in Life Sciences over the years. It will provide a foundation of biology by uncovering various players in the machinery of biological processes. I will also be helpful in technical, scientific analysis with historical background for a robust understanding of various discoveries. Critical

analysis of the history of biology would surely help students comprehend futuristic scientific discoveries.

Learning outcomes

The Learning Outcomes of this course are as follows:
The students will be able:

- Students will be able to learn how was light manipulated during the past to peer into previously invisible world—those too small or too far away to be seen by the naked eye.
- Students will learn about experiments that had fundamental contribution to our present understanding of key molecular elements of life. They will understand how to examine microbial cells and colonies, using various techniques to manipulate color, size, and contrast in ways that helped Scientists to identify species and diagnose disease.
- Studying this unit, students would come to know that there were three group of Naturalists working simultaneously to find answers to inheritance, evolution and basic composition of life. Students will be divulged with hereditary aspects of life. They will get familiar with genes and their roles in living organisms.
- Having understood the relationship of genes and inheritance, students would find interesting to learn the mystical molecule that make up these genes. Sequential study of these experiments would step by step unravel the mystery of genetic material.
- Students at this point of course would be curious to know the structure of molecule that forms the genetic material. They would learn how the information present on DNA manifests itself as specific characteristic features and help in diversity among organisms.
- Students will be explained how the in depth knowledge about became the most important tool for in vitro research, modification and applications thereof.
- Students will be briefed about some landmark discoveries which helped the field of medicine to grow tremendously and played a significant role in improving the overall health of the human population.
- Students can be given small projects to write discoveries done in conventional way.
- They will be required to provide a descriptive view of the topics assigned to them. Students should highlight the research topic with reference to current understanding.

SYLLABUS OF GE-2

UNIT – I View of the invisible Biology (6 Hours)
Rudimentary microscopes to magnify objects; Use of eye glasses as simplest microscopes - Flea or fly glasses; Observing nature in the new world under lens; Book of Optics; Scientific use of Microscopes; Importance of Malphigi microscope that used field lens; Compound Microscope; Robert Hooke's observations in Micrographia; Foldscope by Manu Prakash

UNIT – II Origin of Life – A question (6 Hours)
Spontaneous generation versus biogenesis; Problem of spores; Microbiology and Medicine - Germ theory of Disease; Recognition of agents of infection – Koch's Postulates.

UNIT – III Understanding Biology by observations (6 Hours)
A) Study of evolution of life: Darwins Theory (B) Study of Inheritance of Life: classical era with contributions of Aristotle, Epicurus, and others; Modern genetics: Gregor Johann Mendel, his work on pea plants, theory of Mendelian inheritance (C) Study of composition of Life : Levels of cellular and molecular organization; Cells, tissues and organs in our body; Pioneers of chromosome studies; Discovery of nucleic acids; Nuclein verified as a distinct chemical entity; Early identification of purines and pyrimidines; building blocks of Nucleic

acids and proteins; Chemistry of Nucleic acids; Levene's tetranucleotide hypothesis.

UNIT – IV DNA as the hereditary material – An experimental view (4.5 Hours)
Transformation: Classic work of Frederick Griffith; DNA as the Pneumococcal Transforming Factor; In vitro Transformation system; Announcement that the transforming Principle was DNA; Mirsky's Criticism; The Avery, MacLeod and McCarty proclamation; Additional experiments that supported DNA as the transforming principle; Hershey and Chase clinched the role of DNA as the Genetic Material

UNIT – V Solving the puzzle of DNA structure (4.5 Hours)
Early studies of diffraction of X Rays by DNA fibers – contributions of Rosalind Franklin; Use of X – rays in medicines and research; Erwin Chargaff's discovery of base complementarity in DNA; Watson and Crick model of DNA; Contribution of Linus Pauling; DNA is replicated in Semi-conservative Fashion; Deciphering the Genetic Code; One Gene One Enzyme Edict.

UNIT – VI Technical advancements in biology (6 Hours)
Polymerase Chain Reaction – a revolution in modern biology; DNA Manipulations using Restriction enzymes; Discovery of reverse transcriptase leading to development of RT-PCR for RNA amplification; Work of Stanley Cohen and Herbert Boyer; Advent of gene cloning - History and current applications

UNIT – VII Research as a backbone of modern medicine (6 Hours)
(A) Discovery of antimicrobial agents; Contribution of Joseph Lister and later by Alexander Flemming leading to Discovery of Magic bullets; (B) Control of Infectious Diseases – Variolation, mithridatism and vaccination from the view of Edward Jenner; Vaccine production strategies – with examples of BCG and SARS-CoV2 vaccines; Historical timeline of vaccination strategies; (C) Marie Curie – Use of radiation in medicine.

UNIT – VIII Project Work [On any one topic] (6 Hours)
Study historical research papers and provide a descriptive view of research that was carried out by Scientists as Minor Project.
(A) Ancient system of medicine
(B) Contribution of any one Indian Scientists in Biology
(C) Contribution of any Physicists or Chemists in Biology (for topics listed above)

Practical component (if any) - (30 Hours)
(Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)
1. Comparison of invisible life under the view of microscopes versus foldscope.
2. Cells as a unit of life and observation under the microscopes.
3. How do the cells divide – a view under the microscope: (mount of an onion root tip, onion bud cells or grasshopper testis).
4. Mendel's laws of inheritance – clues from nature.
5. Extraction of genomic DNA
6. Use of electric field to analyse DNA and other biomolecules.
7. Sneak Peek through the discovery of Polymerase chain reaction (PCR): Demonstration of original method and comparison with today's sophistication.
8. To test Flemming's hypothesis that the mold killed the bacteria.
9. Group Discussion on Research Topics assigned to students.

Essential readings

- Alberts, B et al. (2014). 6th edition. Molecular Biology of the Cell. W. W. Norton & Company. ISBN-13 : 978-0815345244
- Bryson, B. (2003) A short history of nearly everything. Transworld Publishers. London W5 5SA. A Random House Group Company. ISBN: 9780552997041.
- Lodish H et al. (2003). 5th Revised edition. Molecular Cell Biology. W.H.Freeman& Co Ltd; ISBN-13 : 978-0716743668
- Green, M. R. and Sambrook, J. (2012). 4th Edition. Molecular Cloning: A Laboratory Manual, New York, United States: Cold Spring Harbor Laboratory Press, ISBN-13:978-1936113422.
- Kornberg, A. (2005). 2nd Edition. DNA Replication. California, United States: University Science Books, ISBN-13: 978-1891389443.

Suggestive readings -

- Watson, J. D. (2011) The Double Helix – A personal account of the discovery of the structure of DNA. Scribner. ISBN 9780743219174.
- Cooper, G. M. and Hausman, R. E. (2013). 6th Edition. The cell: A molecular approach. Massachusetts, USA: Sinauer Associates. ISBN-13:978-1605351551
- Karp, G. (2013). 7th Edition. Cell and molecular biology: Concepts and experiments. New Jersey, USA: Wiley Publishers. ISBN-978-0470483374.
- Cox, M. M. Doudna J. A. and Donnell, M. O. (2012). 1st Edition. Molecular Biology: Principles and Practice. London, United Kingdom: W H Freeman & Co Publishers, ISBN-13: 978-0-716-7998-8.
- Watson, J. D. Baker T. A. Bell, S. P. Gann, A. Levine, M. and Losick, R. (2013). 7th
- Edition. Molecular Biology of the Gene. New York, United States: Cold Spring
- Harbor Laboratory Press, ISBN-13: 978-0-321-76243-6.

GENERIC ELECTIVES (GE-3): TOXIC SUBSTANCES AND HUMAN HEALTH

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
TOXIC SUBSTANCES AND HUMAN HEALTH	**4**	**3**	**-**	**1**	**Open to Students from all subjects**	**NA**

Learning Objectives

The Learning Objectives of this course are as follows:

In daily life, humans are exposed to several toxic substances. Many household products, medicines, cosmetic products, paints, and even food and water may contain toxic substances.; Frequent or improper use of many consumer products or exposure to higher amounts than prescribed, may cause serious health problems. This paper introduces the common toxic substances to which humans are routinely exposed; and health related issues in case of toxicity.

Learning outcomes

The Learning Outcomes of this course are as follows:
After studying, students will be able to:

- Introduction to the various toxic substances and how humans come in contact with toxic hazards. Definitions of various terminologies used in toxicology, and methods of assessment of toxicity of a substance are also covered.
- Upon contact with humans, toxic compounds may be absorbed in the body, and distributed to various organs to show toxic effects. Toxic compounds, once inside the body, are also metabolized or chemically altered. In most cases, after metabolism, the physicochemical properties of toxicants are altered, which helps in their speedy removal from the body.
- Many household products contain substances/ingredients which, if properly not used or applied on the body in excess, can cause serious health effects. These substances include cleaners, household pesticides, cosmetics, disposable utensils, paints, polish, etc. Students will be introduced to few such ingredients and their harmful effects.
- In addition to nutrients, our food also contains several substances which are unavoidable or added unintentionally. These substances and food adulterants, if taken for long time can cause adverse effects.
- Drugs are used to treat diseases. However, if taken at high dose (such as overdosing), drugs act as potential toxic substances. Moreover, several drugs have side effects even at prescribed dose or if used for prolonged duration.
- Anthropogenic activity and natural causes in some cases leads to contamination of soil, water and air with several potential toxicants. These toxicants enter human body via air that we breathe, drinking water and food. With examples of a few toxic substances, students will be introduced how toxicants enter the body from the environment and the adverse health effects caused by them.

SYLLABUS OF GE-3

UNIT – I Introduction to toxic substances and assessment of toxicity (9 Hours)
Types of toxic substances, human contact/exposure with toxic substances (occupational, intentional, accidental etc.); various definitions (toxin, toxicants, xenobiotics, exposure, acute toxicity, chronic toxicity etc); Dose Response Relationship, efficacy, potency, LD50, TD50, NOAEL, ADI; selective toxicity.

UNIT – II Movement of toxic substances inside the body (6 Hours)
Brief introduction to absorption of toxicants via various routes, concept of bioavailability, first pass metabolism, distribution and excretion.

UNIT – III Household toxicants (9 Hours)
Route of exposure, mechanism of toxicity and health effects of common household toxicants:
i). Cleaners, disinfectants, air fresheners (sodium hypochlorite, ammonia, phenol, naphthalene, 1, 4-Dichlorobenzene, methanol).
ii). Garden products, and home mosquito repellents and rat kills (pesticides: organophosphates, pyrethroids, aluminium and zinc phosphide).
iii). Cosmetic products (metals: lead, cadmium; solvents: toluene, acetone).
iv). Other products: disposable utensils (styrene), antifreezing agents (ethylene glycol), Volatile Organic Compounds (VOCs).

UNIT – IV Toxicants and toxins in food (6 Hours)
Mechanism of toxicity and health effects of:
i. Pesticide residues (DDT, lindane)
ii. Toxins (amatoxin, muscarine, bacterial toxins)
Brief discuss on food preservatives, colouring agents and flavouring agents etc, and food adulterants.

UNIT – V Drugs as toxicants (6 Hours)
Brief introduction of drugs as toxicants with examples; adverse effects of drugs at therapeutic doses, and overdosing.

UNIT – VI Environmental toxicants (9 Hours)
Route of exposure, mechanism of toxicity and health effects of:
i. Industrial chemicals (mercury, Polycyclic Aromatic Hydrocarbons, dioxins).
ii. Gaseous air pollutants (nitrogen oxides, sulfur dioxide, carbon monoxide).
iii. Particulate matter (PM).

Practical component - (30 Hours)
(Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)
1. Calculation of LD50 value of an insecticide from the data provided.
2. To estimate formaldehyde content in the given sample.
3. To detect presence of paracetamol in the given sample.
4. Analysis of sodium hypochlorite content in various household products.
5. To detect primary alcohol in sample/ household products.
6. To detect aromatic amines in the sample/ household products.
7. To study various toxic substances in terms of exposure, health effects, from various online resources (such as https://www.atsdr.cdc.gov/ , TOXNET or other sources)
8. To separate a mixture of naphthol and naphthalene by solvent extraction method.

Essential readings

- Klaassen, C.D. (2018). 9th Edition. Casarett and Doull’s Toxicology, The Basic
- Science of the Poisons. McGraw Hill. ISBN-13: 978-1259863745.
- Stine, K.E. and Brown T.M (2015). 3rd Edition. Principles of Toxicology.
- Florida, USA: CRC Press. ISBN-13: 9781466503434.
- Timbrell. J. (2001). 3rd Edition. Introduction to Toxicology. CRC Press. ISBN13: 978-0415247634.

Suggestive readings

- https://www.atsdr.cdc.gov/
- https://www.cdc.gov/
- Klaassen, C.D and Watkins, J.B. (2015). 3rd Edition. Casarett and Doull’s
- Essentials of Toxicology. McGraw Hill Education. ISBN-13:978-0071847087.
- Klaassen, C.D and Watkins, J.B. (2021). 4th Edition. Casarett and Doull’s
- Essentials of Toxicology. McGraw Hill, ISBN-13: 978-1260452297.

DEPARTMENT OF GEOLOGY

BSC (Hons.) Geology
Category-I

DISCIPLINE SPECIFIC CORE COURSE – 1 (DSC-1) Earth System Science

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Earth System Science	**4**	**3**	**0**	**1**	**B.Sc. Hons. Geology students only**	**NIL**

Learning Objectives

Introduction to the subject Geology. Holistic understanding of Earth as a planet in the Solar System and its relationships with other terrestrial planets. Understanding of the processes occurring in lithosphere, hydrosphere, biosphere, and atmosphere

Learning outcomes

After completion of this course, students will be able to understand and comprehend the connectivity and dynamics of the atmosphere, lithosphere, and hydrosphere of the Earth. A thorough understanding of Geology, its various branches and the overall scope of Earth Science will be possible through this course.

SYLLABUS OF DSC-1

Unit 1: **(12 Hours)**

Holistic understanding of dynamic planet 'Earth' and its orbital parameters. Introduction to various branches of Earth Sciences. General characteristics and theories about the origin of the Universe including our Solar System and its planets. The terrestrial and Jovian planets. Interior of the Earth. Meteorites and Asteroids. Earth’s origin, size, shape, mass, density, rotational and revolution parameters. Methods to determine age of the Earth. Earth’s Magnetic Field and Palaeomagnetism. Applications of paleomagnetism.

Unit 2: **(9 Hours)**

Plate Tectonics: Concept of plate tectonics, sea-floor spreading and continental drift.
Earthquake and earthquake belts; Volcanoes- types, products and distribution of volcanic belts.

Unit 3: **(9 Hours)**

Hydrosphere and Atmosphere: Layers of the Atmosphere. Various cells of the atmospheric circulation. World surface oceanic currents and their distribution. Earth's heat budget. Orogeny and epeirogeny. Major mountain belts of the world.

Unit 4: (15 Hours)

Understanding the past from geologic records; Nature of geologic records; Standard Geological time scale and introduction to the concept of time in geological studies; Introduction to geochronological methods and their application in geological studies. History of development in concepts of uniformitarianism, catastrophism, and Neptunism, Physiographic divisions of India.

Practical (30 Hours)

1. Study of major geomorphic features and their relationships with outcrops through physiographic models.
2. Detailed study of topographic sheets and preparation of physiographic description of an area
3. Study of distribution of major dams on map of India and their impact on river systems
4. Study of major ocean currents of the World
5. Study of different rock types
6. Study of fossils and their application
7. Study of physiographic map of earth during different Geological ages

Essential readings

- Cesare Emiliani,1992; Planet Earth: Cosmology, Geology, and the Evolution of Life and Environment
- Arthur Holmes, 197; Holmes Principles Of Physical Geology, by John Wiley & Sons

Suggestive readings (if any)

- Physical Geology, 15th Edition, Charles C. Plummer, Diane H. Carlson, Lisa Hammersley McGraw-Hill Education- 2016
- Essentials of Geology, 13th Edition Frederick K. Lutgens, Edward J. Tarbuck, Dennis G. Tasa- Pearson Publications 2016
- Emiliani, C. (1992). Planet earth: cosmology, geology, and the evolution of life and environment. Cambridge University Press.
- Gross, M. G. (1977). Oceanography: A view of the earth.
- Duff, P. M. D. & Duff, D. (Eds.). (1993). Holmes' principles of physical geology. Taylor & Francis.

DISCIPLINE SPECIFIC CORE COURSE – 2 (DSC-2) : Mineral Science

Credit distribution, Eligibility and Prerequisites of the Course

Course t itle & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite o f the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Mineral Science	4	3	0	1	B.Sc. Hons. Geology students only	NIL

Learning Objectives

Major objectives for this course are to understand:
1. the characteristics of major mineral groups in hand specimen and thin section
2. phase equilibria, formation environments and associations of rock-forming minerals
3. crystal symmetry, crystallography, and atomic structure

Learning outcomes

At the end of this course, you will be able to:
1. identify common rock-forming minerals in hand specimens and in thin sections using diagnostic physical, optical, and chemical properties.
2. infer something about the formation environment of a silicate mineral using only its formula;
3. read a phase diagram;
4. predict the physical properties of a substance from its symmetry content;
5. plot crystal faces on a stereo projection

SYLLABUS OF DSC- 2

Unit 1: Chemical and Physical Fundamentals

- Importance of minerals, the definition of a mineral, atoms, ions, periodic table, bonding in minerals, compositional variations in minerals. **(6 Hours)**
- Crystallization, crystal imperfections (defects, zoning, twinning), crystal precipitation, mineral classification schemes, and physical properties of minerals (appearance, crystal shape, strength, density, magnetism, reaction with acid). **(6 Hours)**
- Polarized light, refractive index, uniaxial and biaxial indicatrixes, interference figures. **(3 Hours)**

Unit 2: Rock-forming minerals

- Igneous minerals (silicates), phase relations **(6 Hours)**
- Sedimentary minerals (zeolites, clays, sulfates, halides, oxides, carbonates), weathering processes. **(6 Hours)**
- Metamorphic minerals, textures, reactions, phase equilibria. **(3 Hours)**

- Economic minerals (magmatic, hydrothermal, and sedimentary ores; native metals, sulfides and sulfosalts, oxides and hydroxides, gemstones) (**3 Hours)**

Unit 3: Symmetry, Crystallography, and Atomic Structure

- Symmetry, stereo diagrams, forms and crystal morphology. **(3 Hours)**

- Unit cells and lattices in two dimensions and three dimensions, Bravais lattices, unit cell symmetry and crystal symmetry, crystal structures, crystal habit and crystal faces. **(6 Hours)**
- Ionic radii, coordination number, packing, Pauling's rules, silicate structures, substitutions, structures of non-silicates. **(3 Hours)**

Practical:

1. Study of physical properties of minerals in hand specimen
   Silicates: Olivine, Garnet, Kyanite, Staurolite, Tourmaline, Serpentine, Talc, Muscovite, Biotite, Quartz, Orthoclase, Plagioclase, Microcline, Nepheline, Sodalite. Quartz varieties: Chert, Flint, Chalcedony, Agate, Jasper, Amethyst, Rosequartz, Smoky quartz, Rock crystal. Native Metals/non-metals, Sulfides, Oxides-Copper, Sulfur, Graphite, Pyrite, Corundum, Magnetite Hydroxides, Halides, Carbonates, Sulfates, Phosphates: Psilomelane, Fluorite, Calcite, Malachite, Gypsum, Apatite.
2. Study of some key silicate minerals under an optical microscope and their characteristic properties.
3. Mineral stochiometry related numerical.
4. Numericals related to parameters and indices of crystals faces.
5. Stereographic projection of crystal faces.

Essential readings

- Cornelis Klein and Barbara Dutrow, The manual of Mineral Science, Wiley Publication 2007
- Nesse W. D., Introduction to Optical mineralogy.2008, Oxford University Press.
- Deer W. A., Howie.R. A. and Zussman, J., An introduction to the rock-forming minerals 1992

Suggestive readings

1. Cornelis Klein and Barbara Dutrow, The manual of Mineral Science, Wiley Publication 2007
2. Nesse W. D., Introduction to Optical mineralogy.2008, Oxford University Press.
3. Deer W. A., Howie.R. A. and Zussman, J., An introduction to the rock-forming minerals 1992

DISCIPLINE SPECIFIC CORE COURSE– 3 (DSC-3) Concepts of Stratigraphy

Credit distribution, Eligibility and Pre-requisites of the Course

Course t itle & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of t he course(if any)
		Lecture	Tutorial	Practical/ Practice		
Concepts of Stratigraphy	4	3	0	1	B.Sc. Hons. Geology students only	NIL

Learning Objectives

This is to introduce students with the fundamental concepts of stacking of sediments in both space and time based on principles of stratigraphy and sedimentation.

Learning outcomes

Students will be able to learn the distribution of sedimentary rocks in both space and time and appreciate the stacking of sediments following the fundamental concepts of stratigraphy

SYLLABUS OF DSC-3

Unit 1: Principles of stratigraphy, geological time scale **(3 Hours)**

Unit 2: Stratigraphic units: lithostratigraphic, chronostratigraphic and biostratigraphic units **(2 weeks)**

Unit 3: Stratigraphic classification and correlation. Methods of collecting stratigraphic data, identification of stratigraphic contacts and unconformities. **(6 Hours)**

Unit 4: Facies concept in stratigraphy. Applications of lithostratigraphy **(3 Hours)**

Unit 5: Fossils and stratigraphy; Evolutionary trends, Biozones and zone fossils **(3 Hours)**

Unit 6: Biostratigraphy in relation to other stratigraphic techniques **(6 Hours)**

Unit 7: Radiometric dating (K-Ar, Rb-Sr, U-Pb) and correlation techniques **(6 Hours)**

Unit 8 : Basic principles of magnetostratigraphy, seismic stratigraphy and sequence stratigraphy. **(6 Hours)**

Unit 9: Concept of Stratotypes. Global Stratotype Section and Point (GSSP). International and Indian code for stratigraphic classification. **(6 Hours)**

Practical (30 Hours)

Preparation and study of stratigraphic maps:

a) Correlation diagrams using lithologs of fossiliferous and non-fossiliferous stratigraphic units. Geophysical logs.
b) Examination of isopach and isofacies maps.

c) Exercises related to stratigraphic classification and correlation.

Essential readings

- Blatt, H., Berry, W.B. and Brande, S., 1991. Principles of stratigraphic analysis. Blackwell scientific publications, Oxford
- Nicols G., 2009 Sedimentology and Stratigraphy 2nd Edition, Wiley-Blackwell
- Brookfield, M.E., 2016 Principles of stratigraphy, Wiley India

Suggestive readings

1. Blatt, H., Berry, W.B. and Brande, S., 1991. Principles of stratigraphic analysis. Blackwell scientific publications, Oxford Annexure-III Page 24 of 25
2. Nicols G., 2009 Sedimentology and Stratigraphy 2nd Edition, Wiley-Blackwell
3. Brookfield, M.E., 2016 Principles of stratigraphy, Wiley India

COMMON POOL OF GENERIC ELECTIVES (GE) COURSES

Offered by Department of Geology

Category-IV

GENERIC ELECTIVES (GE-1): Essentials of Geology

Credit distribution, Eligibility and Pre-requisites of the Course

Course t itle & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of t he course
		Lecture	Tutorial	Practical/ Practice		
Essentials of Geology	4	4	0	0	12th Pass	Nil

Learning Objectives

1. Interactive and interdisciplinary nature of geology
2. Interplanetary scope of geology
3. Introduction to atmosphere, hydrosphere, biosphere and lithosphere

Learning outcomes

1. Earth, its origin and concept of geological time
2. Formation of planets and solar system
3. Composition of inner as well as surficial components of planet earth
4. Major geomorphic features, and compositions of various parts of earth and major earth processes
5. Earth Resources

SYLLABUS OF GE-1

Unit 1: Introduction to geology, scope, sub-disciplines and relationship with other branches of sciences Solar system and its origin: Terrestrial and Jovian planets; Nebular hypothesis. Earth's size, shape, mass, density, rotational and evolutional parameters Earth in comparison to other bodies in the solar system. **(16 Hours)**

Unit 2: Internal constitution of the earth - core, mantle and crust (Chemical and mechanical differentiation) Convections in the earth's core and production of magnetic field; Concept of Plate Tectonics as a unifying theory. **(16 Hours)**

Unit 3: Origin and composition of hydrosphere and atmosphere; Origin of biosphere; Origin of oceans, continents and mountains. **(12 Hours)**

Unit 4: Geological Time Scale Radioactivity dating and its application in determining the age of the rocks. Earth Resources and their sustainable use. **(16 Hours)**

Essential readings

- Holmes, A. (1992). Principles of Physical Geology, 1992, Chapman and Hall.
- Emiliani, C. (1992). Planet Earth, Cosmology, Geology and the Evolution of Life and
- Environment, Cambridge University Press.

Suggestive readings

1. Holmes, A. (1992). Principles of Physical Geology, 1992, Chapman and Hall.
2. Emiliani, C. (1992). Planet Earth, Cosmology, Geology and the Evolution of Life and Annexure-IV Page 25 of 25 Environment, Cambridge University Press.
3. Gross, M.G. (1977). Oceanography: A view of the Earth, Prentice Hall.
4. Grotzinger, J.P. & Jordan, T.H. (2020) Understanding Earth. 8th Edition, W.H. Freeman and Company

DEPARTMENT OF PHYSICS

BSc. (Hons.) Physics

Category-I

DISCIPLINE SPECIFIC CORE COURSE – 1 (DSC-1) Mathematical Physics I

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Mathematical Physics I	4	3	0	1	Class XII pass with Physics and Mathematics as main subjects	Physics and Mathematics syllabus of class XII

Learning Objectives

The emphasis of the course is on applications in solving problems of interest to physicists. The course will teach the students to model a physics problem mathematically and then solve those numerically using computational methods. The course will expose the students to fundamental computational physics skills enabling them to solve a wide range of physics problems. The skills developed during course will prepare them not only for doing fundamental and applied research but also for a wide variety of careers.

Learning Outcomes

After completing this course, student will be able to,

- Draw and interpret graphs of various elementary functions and their combinations.
- Understand the vector quantities as entities with Cartesian components which satisfy appropriate rules of transformation under rotation of the axes.
- Use index notation to write the product of vectors in compact form easily applicable in computational work.
- Solve first and second order differential equations and apply these to physics problems.
- Understand the functions of more than one variable and concept of partial derivatives.
- Understand the concept of scalar field, vector field, gradient of scalar field and divergence and curl of vector fields.
- Perform line, surface and volume integration and apply Green's, Stokes' and Gauss's theorems to compute these integrals and apply these to physics problems
- Understand the properties of discrete and continuous distribution functions.

In the laboratory course, the students will learn to,

- Prepare algorithms and flowcharts for solving a problem.
- Design, code and test simple programs in Python/C++ to solve various problems.

- Perform various operations of 1-d and 2-d arrays.
- Visualize data and functions graphically using Matplotlib/Gnuplot

SYLLABUS OF DSC – 1

THEORY COMPONENT

Unit 1 (18 Hours)

Functions: Plotting elementary functions and their combinations, Interpreting graphs of functions using the concepts of calculus, Taylor's series expansion for elementary functions.

Ordinary Differential Equations: First order differential equations of degree one and those reducible to this form, Exact and Inexact equations, Integrating Factor, Applications to physics problems

Higher order linear homogeneous differential equations with constant coefficients, Wronskian and linearly independent functions. Non-homogeneous second order linear differential equations with constant coefficients, complimentary function, particular integral and general solution, Determination of particular integral using method of undetermined coefficients and method of variation of parameters, Cauchy-Euler equation, Initial value problems. Applications to physics problems

Unit 2 (12 Hours)

Vector Algebra: Transformation of Cartesian components of vectors under rotation of the axes, Introduction to index notation and summation convention. Product of vectors - scalar and vector product of two, three and four vectors in index notation using δ_{ij} and ε_{ijk} (as symbols only – no rigorous proof of properties). Invariance of scalar product under rotation transformation.

Vector Differential Calculus: Functions of more than one variable, Partial derivatives, chain rule for partial derivatives. Scalar and vector fields, concept of directional derivative, the vector differential operator $\vec{\nabla}$, gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field and their physical interpretation. Laplacian operator. Vector identities.

Unit 3 (15 Hours)

Vector Integral Calculus: Integrals of vector-valued functions of single scalar variable. Multiple integrals, Jacobian, Notion of infinitesimal line, surface and volume elements. Line, surface and volume integrals of vector fields. Flux of a vector field. Gauss divergence theorem, Green's and Stokes' Theorems (no proofs) and their applications

Probability Distributions: Discrete and continuous random variables, Probability distribution functions, Binomial, Poisson and Gaussian distributions, Mean and variance of these distributions.

PRACTICAL COMPONENT (30 Hours)

The aim of this lab is not just to teach computer programming and numerical analysis but to emphasize its role in solving problems in Physics. The course will consist of practical sessions and lectures on the related theoretical aspects of the laboratory. Assessment is to be done not only on the programming but also on the basis of formulating the problem.

- Every student must perform at least 6 programs covering each unit.
- The list of recommended programs is suggestive only. Students should be encouraged to do more practice. Emphasis should be given to assess student's ability to formulate a physics problem as mathematical one and solve by computational methods.
- The implementation can be either in Python or C++. Accordingly, the instructor can choose section A or B respectively from Unit 1 and 2. The list of programs is common for both sections. If C++ is used, then for all plotting programs, Gnuplot has to be used.

Basics of scientific computing (Mandatory):

(a) Binary and decimal arithmetic, Floating point numbers, single and double precision arithmetic, underflow and overflow, numerical errors of elementary floating point operations, round off and truncation errors with examples.

(b) Introduction to Algorithms and Flow charts. Branching with examples of conditional statements, for and while loops.

Unit 1

Section A:

Basic Elements of Python: The Python interpreter, the print statement, comments, Python as simple calculator, objects and expressions, variables (numeric, character and sequence types) and assignments, mathematical operators. Strings, Lists, Tuples and Dictionaries, type conversions, input statement, list methods. List mutability, Formatting in the print statement.

Control Structures: Conditional operations, if, if-else, if-elif-else, while and for loops, indentation, break and continue, List comprehension. Simple programs for practice like solving quadratic equations, temperature conversion etc.

Functions: Inbuilt functions, user-defined functions, local and global variables, passing functions, modules, importing modules, math module, making new modules. Writing functions to perform simple operations like finding largest of three numbers, listing prime numbers, etc., Generating pseudo random numbers.

OR

Section B:

Introduction to C++: Basic idea of Compilers. Structured programming. Idea of Headers, Data Types, Enumerated Data, Conversion and casting, constants and variables, Mathematical, Relational, Logical and Bit wise Operators. Precedence of Operators, Expressions and Statements, Scope and Visibility of Data, block, Local and Global variables, Auto, static and External variables. Input and output statements. I/O manipulations, iostream and cmath header files, using namespace.

Control Statements: The if-statement, if-else statement, Nested if Structure, If - Else if – else block, Ternary operator, Goto statement, switch statement, Unconditional and Conditional looping, While loop, Do-while loop, For loop, nested loops, break and continue statements. Simple programs for practice like solving quadratic equations, temperature conversion etc.

Functions: Inbuilt functions. User-defined functions, function declaration, function definition, function prototype, void functions and function arguments, return statement. Local and global variables. The main function. Passing parameter by value and by reference. Inline functions. Function overloading. Writing functions to perform simple operations like finding largest of three numbers, listing prime numbers etc., Generating pseudo random numbers.

Recommended List of Programs (At least Two)

(a) Make a function that takes a number N as input and returns the value of factorial of N. Use this function to print the number of ways a set of m red and n blue balls can be arranged.
(b) Generate random numbers (integers and floats) in a given range and calculate area and volume of regular shapes with random dimensions.
(c) Generate data for coordinates of a projectile and plot the trajectory. Determine the range, maximum height and time of flight for a projectile motion.

Unit 2

Section A:

NumPy Fundamentals: Importing Numpy, Difference between List and NumPy array, Adding, removing and sorting elements, creating arrays using ones(), zeros(), random(), arange(), linspace(). Basic array operations (sum, max, min, mean, variance), 2-d arrays, matrix operations, reshaping and transposing arrays, savetxt() and loadtxt().

Plotting with Matplotlib: matplotlib.pyplot functions, Plotting of functions given in closed form as well as in the form of discrete data and making histograms.

OR

Section B:

Arrays: Array definition, passing arrays to functions, Finding sum, maximum, minimum, mean and variance of given array. 2-d arrays, matrix operations (sum, product, transpose etc). Saving data generated by a C++ program in a file.

Gnuplot: Introduction to Gnuplot. Visualization of discrete data and plotting functions given in closed form and data for graphical visualization. Plotting data from the output file created by a C++ program, making histogram.

Recommended List of Programs (At least Three)

(a) To plot the displacement-time and velocity-time graph for the un-damped, under-damped critically damped and over-damped oscillator using matplotlib (or Gnuplot) using given formulae.

(b) To compute the left, right and central approximations for derivative of a function given in closed form. Plot both the function and derivative on the same graph. Plot (using matplotlib/Gnuplot) the error as a function of step size on a log-log graph, study the behaviour of the plot as step size decreases and hence discuss the effect of round off error.

(c) To generate array of N random numbers drawn from a given distribution (uniform, binomial, poisson and gaussian) and plot them using matplotlib/Gnuplot for increasing N to verify the distribution. Verify the central limit theorem.

(d) To implement the transformation of physical observables under Galilean, Lorentz and Rotation transformation

Unit 3

Recommended List of Programs (At least one)

(a) To find value of π and to integrate a given function using acceptance-rejection method.

(b) To perform linear fitting of data using the inbuilt function scipy.stats.linregress in Python or using Gnuplot. Plot the data points and the fitted line on the same graph.

References (for Laboratory Work):

1) Documentation at the Python home page (https://docs.python.org/3/) and the tutorials there (https://docs.python.org/3/tutorial/).
2) Documentation of NumPy and Matplotlib : https://numpy.org/doc/stable/user/ and https://matplotlib.org/stable/tutorials/
3) Schaum's Outline of Programming with C++, J. Hubbard, 2000, McGraw-Hill Education.
4) C++ How to Program, Paul J. Deitel and Harvey Deitel, Pearson (2016).
5) Computational Physics, Darren Walker, 1st Edn., Scientific International Pvt. Ltd (2015).
6) Elementary Numerical Analysis, K. E. Atkinson, 3rd Edn., 2007, Wiley India Edition.
7) An Introduction to Computational Physics, T. Pang, Cambridge University Press (2010).
8) Introduction to Numerical Analysis, S. S. Sastry, 5th Edn., 2012, PHI Learning Pvt. Ltd.
9) Applied numerical analysis, Cutis F. Gerald and P. O. Wheatley, Pearson Education, India (2007).

Essential/Recommended Readings

REFERENCES FOR THEORY COMPONENT

1) An introduction to ordinary differential equations, E.A. Coddington, 2009, PHI learning.
2) Differential Equations, George F. Simmons, 2007, McGraw Hill.
3) Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, Viva Book.
4) Advanced Engineering Mathematics, D.G. Zill and W.S. Wright, 5 Ed., 2012, Jones and Bartlett Learning.

5) Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.
6) Probability and Statistics, Murray R Spiegel, John J Schiller and R Alu Srinivasan, 2018, McGraw Hill Education Private Limited.
7) Essential Mathematical Methods, K.F.Riley and M.P.Hobson, 2011, Cambridge Univ. Press.
8) Vector Analysis and Cartesian Tensors, D.E. Bourne and P.C. Kendall, 3 Ed. , 2017, CRC Press.
9) Vector Analysis, Murray Spiegel, 2 Ed., 2017, Schaum's outlines series.
10) John E. Freund's Mathematical Statistics with Applications, I. Miller and M. Miller, 7th Ed., 2003, Pearson Education, Asia.

.Suggestive readings:

1) Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 7 Ed., 2013, Elsevier.
2) Introduction to Electrodynamics, Chapter 1, David J. Griffiths, 4 Ed., 2017, Cambridge University Press.
3) The Feynman Lectures on Physics, Volume II, Feynman, Leighton and Sands, 2008, Narosa Publishing House.
4) Introduction to Vector Analysis, Davis and Snider, 6 Ed., 1990, McGraw Hill.
5) Differential Equations, R. Bronson and G.B. Costa, Schaum's outline series.
6) Mathematical Physics, A.K. Ghatak, I.C. Goyal and S.J. Chua, Laxmi Publications Private Limited (2017)
7) Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.

DISCIPLINE SPECIFIC CORE COURSE – 2 (DSC - 2) MECHANICS

Credit distribution, Eligibility and Prerequisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Mechanics **DSC – 2**	**4**	**3**	**0**	**1**	Class XII pass with Physics and Mathematics as main subjects	Physics and Mathematics syllabus of class XII

Learning Objectives

This course reviews the concepts of mechanics learnt at school from a more advanced perspective and goes on to build new concepts. It begins with Newton's Laws of Motion and ends with the Fictitious Forces and Special Theory of Relativity. The students will learn the collisions in the centre of mass frame, rotational motion and central forces. They will be able to apply the concepts learnt to several real world problems. In the laboratory part of the course, the students will learn to use various instruments, estimate the error for every experiment performed and report the result of experiment along with the uncertainty in the result up to correct significant figures.

Learning Outcomes

Upon completion of this course, students will be able to,

- Learn the Galilean invariance of Newton's laws of motion.
- Understand translational and rotational dynamics of a system of particles.
- Apply Kepler's laws to describe the motion of planets and satellite in circular orbit.
- Understand Einstein's postulates of special relativity.
- Apply Lorentz transformations to describe simultaneity, time dilation and length contraction
- Use various instruments for measurements and perform experiments related to rotational dynamics, elastic properties, fluid dynamics, acceleration due to gravity, collisions, etc.
- Use propagation of errors to estimate uncertainty in the outcome of an experiment and perform the statistical analysis of the random errors in the observations.

SYLLABUS OF DSC- 2

THEORY COMPONENT

Unit 1: (14 Hours)

Fundamentals of Dynamics: Inertial and Non-inertial frames, Newton's Laws of Motion and their invariance under Galilean transformations. Momentum of variable mass system: motion of rocket. Dynamics of a system of particles. Principle of conservation of momentum. Impulse. Determination of Centre of Mass of discrete and continuous objects having cylindrical and spherical symmetry. Differential analysis of a static vertically hanging massive rope

Work and Energy: Work and Kinetic Energy Theorem. Conservative forces and examples (Gravitational and electrostatic), non-conservative forces and examples (velocity dependent forces e.g. frictional force, magnetic force), Potential Energy. Energy diagram. Stable, unstable and neutral equilibrium. Force as gradient of the potential energy. Work done by non-conservative forces.

Collisions: Elastic and inelastic collisions between two spherical bodies. Kinematics of 2 → 2 scattering in centre of mass and laboratory frames.

Unit 2: (12 Hours)

Rotational Dynamics: Angular momentum of a particle and system of particles. Torque. Principle of conservation of angular momentum. Rotation about a fixed axis. Determination of moment of inertia of symmetric rigid bodies (rectangular, cylindrical and spherical) using parallel and perpendicular axes theorems. Kinetic energy of rotation. Motion involving both translation and rotation.

Non-Inertial Systems: Non-inertial frames and fictitious forces. Uniformly rotating frame. Centrifugal force. Coriolis force and its applications.

Unit 3: (7 Hours)

Central Force Motion: Central forces, Law of conservation of angular momentum for central forces, Two-body problem and its reduction to equivalent one-body problem and its solution. Concept of effective potential energy and stability of orbits for central potentials of the form kr^n for n = 2 and -1 using energy diagram, discussion on trajectories for n=-2. Solution of the Kepler Problem, Kepler's Laws for planetary motion, orbit for artificial satellites

Unit 4: (12 Hours)

Relativity: Postulates of Special Theory of Relativity, Lorentz Transformations, simultaneity, length contraction, time dilation, proper length and proper time, life time of a relativistic particle (for example muon decay time and decay length). Space-like, time-like and light-like separated events, relativistic transformation of velocity and acceleration, variation of mass with velocity, mass-energy equivalence, transformation of energy and momentum.

PRACTICAL COMPONENT (30 Hours)

Introductory Concepts and related activities (Mandatory)

- **Use of Basic Instruments**

Determination of least count and use of instruments like meter scale, vernier callipers, screw gauge and travelling microscope for measuring lengths.

- Errors

(a) Types of errors in measurements (instrumental limitations, systematic errors and random errors), accuracy and precision of observations, significant figures.
(b) Introduction to error estimation, propagation of errors and reporting of results along with uncertainties with correct number of significant figures.
(c) Statistical analysis of random errors, need for making multiple observations, standard error in the mean as estimate of the error.

- Graph Plotting

Pictorial visualisation of relation between two physical quantities, Points to be kept in mind while plotting a graph manually.

- Data Analysis

Principle of least square fitting (LSF) and its application in plotting linear relations, estimation of LSF values of slope, intercept and uncertainties in slope and intercept.

Mandatory Activities

- Determine the least count of meter scale, vernier callipers, screw gauge and travelling microscope, use these instruments to measure the length of various objects multiple time, find the mean and report the result along with the uncertainty up to appropriate number of significant digits.
- Take multiple observations of the quantities like length, radius etc. for some spherical, cylindrical and cubic objects, find mean of these observations and use them to

determine the surface area and volume of these objects. Estimate the uncertainties in the outcome using law of propagation of errors. Report the result to appropriate number of significant figures.

- Given a data (x, y) corresponding to quantities x and y related by a relation $y = f(x)$ that can be linearised, plot the data points (manually) with appropriate choice of scale, perform least square fitting to determine the slope and intercept of the LSF line and use them to determine some unknown quantity in the relation. Determine the uncertainties in slope and intercept and use these to estimate the uncertainty in the value of unknown quantity.

Every student must perform at least 4 experiments from the following list.

1) To study the random errors in observations. It is advisable to keep observables of the order of least count of the instruments.
2) To determine the moment of inertia of a symmetric as well as asymmetric flywheel
3) To determine coefficient of viscosity of water by Capillary Flow Method (Poiseuille's method).
4) To determine g and velocity for a freely falling body using Digital Timing Technique.
5) To determine the Young's Modulus of a Wire by Optical Lever Method.
6) To determine the vertical distance between two given points using sextant.
7) To determine the coefficients of sliding and rolling friction experienced by a trolley on an inclined plane.
8) To verify the law of conservation of linear momentum in collisions on air track.

Suggested additional activities:

1) Virtual lab collision experiments on two dimensional elastic and inelastic collisions (for example available on following suggested links
   a) https://archive.cnx.org/specials/2c7acb3c-2fbd-11e5-b2d9-e7f92291703c/collision-lab/#sim-advanced-sim)
   b) https://phet.colorado.edu/en/simulations/collision-lab
2) Amrita Virtual Mechanics Lab: https://vlab.amrita.edu/?sub=1&brch=74

References (for Laboratory Work):

1) Advanced Practical Physics for students, B. L. Flint and H. T. Worshnop, 1971, Asia Publishing House.
2) Engineering Practical Physics, S. Panigrahi and B. Mallick, 2015, Cengage Learning India Pvt. Ltd.
3) Practical Physics, G. L. Squires, 2015, 4/e, Cambridge University Press.
4) A Text Book of Practical Physics, Vol I, Prakash and Ramakrishna, 11/e, 2011, Kitab Mahal.
5) An introduction to Error Analysis: The study of uncertainties in Physical Measurements, J.
R. Taylor, 1997, University Science Books

Essential readings:

FOR THEORY COMPONENT

1) An Introduction to Mechanics (2/e), Daniel Kleppner and Robert Kolenkow, 2014, Cambridge University Press.
2) Mechanics Berkeley Physics Course, Vol. 1, 2/e: Charles Kittel, et. al., 2017, McGraw Hill Education
3) Classical Mechanics by Peter Dourmashkin, 2013, John Wiley and Sons.
4) Theory and Problems of Theoretical Mechanics, Murray R. Spiegel, 1977, McGraw Hill Education.
5) Introduction to Classical Mechanics With Problems and Solutions, David Morin, 2008, Cambridge University Press.
6) Fundamentals of Physics, Resnick, Halliday and Walker 10/e, 2013, Wiley.
7) Introduction to Special Relativity, Robert Resnick, 2007, Wiley.

Suggestive Link:
https://phys.libretexts.org/Bookshelves/Classical_Mechanics/classical_Mechanics_(Dourm ash kin)/

Suggestive readings:
1) Feynman Lectures, Vol. 1, R. P. Feynman, R. B. Leighton, M. Sands, 2008, Pearson Education.
2) University Physics, H. D. Young, R. A. Freedman, 14/e, 2015, Pearson Education.
3) Classical Mechanics, H. Goldstein, C. P. Poole, J. L. Safko, 3/e, 2002, Pearson Education.
4) Newtonian Mechanics, A.P. French, 2017, Viva Books.

DISCIPLINE SPECIFIC CORE COURSE– 3 (DSC – 3) WAVES AND OSCILLATIONS

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Waves and Oscillations **DSC – 3**	**4**	**2**	**0**	**2**	Class XII pass with Physics and Mathematics as main subjects	Physics and Mathematics syllabus of class XII

Learning Objectives
This course reviews the concepts of waves and oscillations learnt at school from a more advanced perspective and goes on to build new concepts. It begins with explaining ideas of free oscillations and superposition of harmonic motion leading to physics of damped and forced oscillations. The course will also introduce students to coupled oscillators, normal

modes of oscillations and free vibrations of stretched strings. Concurrently, in the laboratory component of the course students will perform experiments that expose them to different aspects of real oscillatory systems.

Learning Outcomes

On successful completion of this course, the students will have the skill and knowledge to,

- Understand simple harmonic motion
- Understand superposition of N collinear harmonic oscillations
- Understand superposition of two perpendicular harmonic oscillations
- Understand free, damped and forced oscillations
- Understand coupled oscillators and normal modes of oscillations
- Understand travelling and standing waves, stretched strings

SYLLABUS OF DSC – 3

THEORY COMPONENT

Unit 1: Simple Harmonic Motion (12 Hours)

Differential equation of simple harmonic oscillator, its solution and characteristics, energy in simple harmonic motion, linearity and superposition principle, rotating vector representation of simple harmonic oscillation, motion of simple and compound pendulum (Bar and Kater's pendulum), loaded spring.

Superposition of N collinear harmonic oscillations with (1) equal phase differences and (2) equal frequency differences, Beats

Superposition of two perpendicular harmonic oscillations: Graphical and Analytical Methods. Lissajous Figures with equal and unequal frequencies, effect of variation of phase

Unit 2: Damped and Forced Oscillations (8 Hours)

Damped Oscillations: Equation of motion, dead beat motion, critically damped system, lightly damped system: relaxation time, logarithmic decrement, quality factor

Forced Oscillations: Equation of motion, complete solution, steady state solution, resonance, sharpness of resonance, power dissipation, quality factor

Unit 3: Coupled Oscillations **(6 Hours)**

Coupled oscillators, normal coordinates and normal modes, energy relation and energy transfer, di-atomic molecules, representation of a general solution as a linear sum of normal modes, normal modes of N coupled oscillators.

Unit 4: Wave Motion **(4 Hours)**

One dimensional plane wave, classical wave equation, standing wave on a stretched string (both ends fixed), normal modes. Travelling wave solution

PRACTICAL COMPONENT (60 Hours)

Every student must perform at least 5 experiments

1) Experiments using bar pendulum:
    a) Estimate limits on angular displacement for SHM by measuring the time period at different angular displacements and compare it with the expected value of time period for SHM.
    b) Determine the value of g using bar pendulum.
    c) To study damped oscillations using bar pendulum
    d) Study the effect of area of the damper on damped oscillations. Plot amplitude as a function of time and determine the damping coefficient and Q factor for different dampers.
2) To determine the value of acceleration due to gravity using Kater's pendulum for both the cases (a) T_1≈T_2 and (b) T_1≠T_2 and discuss the relative merits of both cases by estimation of error in the two cases.
3) Understand the applications of CRO by measuring voltage and time period of a periodic waveform using CRO. And study the superposition of two perpendicular simple harmonic oscillations using CRO (Lissajous figures)
4) Experiments with spring and mass system
    a) To calculate g, spring constant and mass of a spring using static and dynamic methods.
    b) To calculate spring constant of series and parallel combination of two springs.
5) To study normal modes and beats in coupled pendulums or coupled springs.
6) To determine the frequency of an electrically maintained tuning fork by Melde's experiment and to verify $\lambda^2 - T$ Law.
7) To determine the current amplitude and phase response of a driven series LCR circuit with driving frequency and resistance. Draw resonance curves and find quality factor for low and high damping.

References (For Laboratory Work):

1) Advanced Practical Physics for students, B. L. Flint and H. T. Worsnop, 1971, Asia Publishing House.
2) Engineering Practical Physics, S. Panigrahi and B. Mallick, 2015, Cengage Learning India Pvt. Ltd.
3) Practical Physics, G. L. Squires, 2015, 4/e, Cambridge University Press.
4) A Text Book of Practical Physics, Vol I and II, Prakash and Ramakrishna, 11/e, 2011, Kitab Mahal.
5) An Introduction to Error Analysis: The study of uncertainties in Physical Measurements,

J. R. Taylor, 1997, University Science Books List of experiments

Essential Readings:

FOR THEORY COMPONENT

1) Vibrations and Waves by A. P. French. (CBS Pub. and Dist., 1987)

2) The Physics of Waves and Oscillations by N.K. Bajaj (Tata McGraw-Hill, 1988)
3) Fundamentals of Waves and Oscillations By K. Uno Ingard (Cambridge University Press, 1988)
4) An Introduction to Mechanics by Daniel Kleppner, Robert J. Kolenkow (McGraw-Hill, 1973)
5) Waves: BERKELEY PHYSICS COURSE by Franks Crawford (Tata McGrawHill, 2007).
6) Classical Mechanics by Peter Dourmashkin, John Wiley and Sons
7) https://phys.libretexts.org/Bookshelves/Classical_Mechanics/classical_Mechanics_(Dou r mashkin)

Suggestive Readings:

1) Fundamentals of Physics, Resnick, Halliday and Walker 10/e, 2013, Wiley.
2) Feynman Lectures, Vol. 1, R. P. Feynman, R. B. Leighton, M. Sands, 2008, Pearson Education.
3) University Physics, H. D. Young, R. A. Freedman, 14/e, 2015, Pearson Education.

BSc. Physical Sciences

Multidisciplinary

DISCIPLINE SPECIFIC CORE COURSE – 1 (PHYSICS DSC - 1)
MECHANICS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Mechanics Physics DSC 1	4	2	0	2	Class XII pass with Physics and Mathematics as main subjects	Physics and Mathematics syllabus of class XII

Learning Objectives

This course reviews the concepts of mechanics learnt at school from a more advanced perspective and goes on to build new concepts. It begins with dynamics of a system of particles and ends with the special theory of relativity. Students will appreciate the concept of rotational motion, gravitation and oscillations. The students will be able to apply the concepts learnt to several real world problems.

Learning outcomes:

Upon completion of this course, students are expected to understand the following concepts.

- Laws of motion and their application to various dynamical situations.
- Conservation of momentum, angular momentum and energy. Their application to basic problems.
- Particle collision (elastic and in-elastic collisions)
- Motion of simple pendulum
- Postulates of special theory of relativity, inertial and non-inertial frame of reference and their transformation, relativistic effects on the mass and energy of a moving body.

In the laboratory course, after acquiring knowledge of how to handle measuring instruments (like screw gauge, vernier calliper and travelling microscope) student shall embark on verifying various principles and associated measurable quantities.

SYLLABUS OF PHYSICS DSC – 1

THEORY COMPONENT

Unit 1: Review of vectors and ordinary differential equation (4 Hours)

Gradient of a scalar field, divergence and curl of vectors field, polar and axial vectors Second order homogeneous ordinary differential equations with constant coefficients (Operator Method Only).

Unit 2: Fundamentals of Dynamics (7 Hours)

Dynamics of a system of particles, centre of mass, determination of centre of mass for discrete and continuous systems having spherical symmetry

Conservation of momentum and energy, Conservative and non-Conservative forces, work – energy theorem for conservative forces, force as a gradient of potential energy. Particle collision (Elastic and in-elastic collisions)

Unit 3: Rotational Dynamics and Oscillatory Motion (8 Hours)

Angular momentum, torque, conservation of angular momentum, Moment of inertia, Theorem of parallel and perpendicular axes (statements only). Calculation of moment of inertia of discrete and continuous objects (1-D and 2-D).

Idea of simple harmonic motion, differential equation of simple harmonic motion and its solution, Motion of simple pendulum, damped harmonic oscillator

Unit 4: Gravitation (3 Hours)

Newton's Law of Gravitation, Motion of a particle in a central force field, Kepler's Laws (statements only)

Unit 5: Special Theory of Relativity (8 Hours)

Frames of reference, Galilean transformations, inertial and non-inertial frames, Michelson Morley's Experiment, postulates of special theory of relativity, length contraction, time dilation, relativistic transformation of velocity, relativistic variation of mass.

References:

Essential Readings:

1) Vector Analysis – Schaum's Outline, M.R. Spiegel, S. Lipschutz, D. Spellman, 2nd Edn., 2009, McGraw- Hill Education.

2) An Introduction to Mechanics (2/e), Daniel Kleppner and Robert Kolenkow, 2014, Cambridge University Press.

3) Mechanics Berkeley Physics Course, Vol. 1, 2/e: Charles Kittel, et. al., 2017, McGraw Hill Education

4) Mechanics, D. S. Mathur, P. S. Hemne, 2012, S. Chand.

5) Intermediate Dynamics, Patrick Hamill, 2010, Jones and Bartlett Publishers.

Additional Readings:

1) Feynman Lectures, Vol. 1, R. P. Feynman, R. B. Leighton, M. Sands, 2008, Pearson Education.

2) University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

3) University Physics, H. D. Young, R. A. Freedman, 14/e, 2015, Pearson Education.

4) Fundamentals of Physics, Resnick, Halliday and Walker 10/e, 2013, Wiley.

5) Engineering Mechanics, Basudeb Bhattacharya, 2/e, 2015, Oxford University Press.

6) Physics for Scientists and Engineers, Randall D Knight, 3/e, 2016, Pearson Education.

PRACTICAL COMPONENT (60 Hours)

The teacher is expected to give basic idea and working of various apparatus and instruments related to different experiments. Students should also be given knowledge of recording and analysing experimental data.

Every student should perform at least 06 experiments from the following list.

1) Measurement of length (or diameter) using vernier calliper, screw gauge and travelling microscope.
2) Study the random error in observations.
3) Determination of height of a building using a sextant.
4) Study of motion of the spring and calculate (a) spring constant and, (b) acceleration due to gravity
5) Determination of moment of inertia of a flywheel.
6) Determination of g and velocity for a freely falling body using digital timing technique.
7) Determination of modulus of rigidity of a wire using Maxwell's needle.
8) Determination of elastic constants of a wire by Searle's method.
9) Determination of value of g using bar pendulum.
10) Determination of value of g using Kater's pendulum.

References (for Laboratory Work):

1) Advanced Practical Physics for students, B. L. Flint and H. T. Worsnop, 1971, Asia Publishing House.
2) Engineering Practical Physics, S. Panigrahi and B. Mallick, 2015, Cengage Learning India Pvt. Ltd.
3) Practical Physics, G. L. Squires, 2015, 4/e, Cambridge University Press.
4) A Textbook of Practical Physics, I. Prakash and Ramakrishna, 11/e, 2011, Kitab Mahal.
5) B. Sc. Practical Physics, Geeta Sanon, R. Chand and Co., 2016.

BSc. Physical Sciences with Electronics

Multidisciplinary

DISCIPLINE SPECIFIC CORE COURSE – 1 (PHYSICS DSC - 1)
MECHANICS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Mechanics Physics DSC 1	4	2	0	2	Class XII pass with Physics and Mathematics as main subjects	Physics and Mathematics syllabus of class XII

Learning Objectives

This course reviews the concepts of mechanics learnt at school from a more advanced perspective and goes on to build new concepts. It begins with dynamics of a system of particles and ends with the special theory of relativity. Students will appreciate the concept of rotational motion, gravitation and oscillations. The students will be able to apply the concepts learnt to several real world problems.

Learning Outcomes

Upon completion of this course, students are expected to understand the following concepts.

- Laws of motion and their application to various dynamical situations.
- Conservation of momentum, angular momentum and energy. Their application to basic problems.
- Particle collision (elastic and in-elastic collisions)
- Motion of simple pendulum
- Postulates of special theory of relativity, inertial and non-inertial frame of reference and their transformation, relativistic effects on the mass and energy of a moving body.

In the laboratory course, after acquiring knowledge of how to handle measuring instruments (like screw gauge, vernier calliper and travelling microscope) student shall embark on verifying various principles and associated measurable quantities.

SYLLABUS OF PHYSICS DSC-1

THEORY COMPONENT

Unit 1: Review of vectors and ordinary differential equation (04 Hours)

Gradient of a scalar field, divergence and curl of vectors field, polar and axial vectors Second order homogeneous ordinary differential equations with constant coefficients (Operator Method Only).

Unit 2: Fundamentals of Dynamics (07 Hours)

Dynamics of a system of particles, centre of mass, determination of centre of mass for discrete and continuous systems having spherical symmetry

Conservation of momentum and energy, Conservative and non-Conservative forces, work – energy theorem for conservative forces, force as a gradient of potential energy. Particle collision (Elastic and in-elastic collisions)

Unit 3: Rotational Dynamics and Oscillatory Motion (08 Hours)

Angular momentum, torque, conservation of angular momentum, Moment of inertia, Theorem of parallel and perpendicular axes (statements only). Calculation of moment of inertia of discrete and continuous objects (1-D and 2-D).

Idea of simple harmonic motion, differential equation of simple harmonic motion and its solution, Motion of simple pendulum, damped harmonic oscillator

Unit 4: Gravitation (03 Hours)

Newton's Law of Gravitation, Motion of a particle in a central force field, Kepler's Laws (statements only)

Unit 5: Special Theory of Relativity (08 Hours)

Frames of reference, Galilean transformations, inertial and non-inertial frames, Michelson Morley's Experiment, postulates of special theory of relativity, length contraction, time dilation, relativistic transformation of velocity, relativistic variation of mass.

References:

Essential Readings:

1) Vector Analysis – Schaum's Outline, M.R. Spiegel, S. Lipschutz, D. Spellman, 2nd Edn., 2009, McGraw- Hill Education.
2) An Introduction to Mechanics (2/e), Daniel Kleppner and Robert Kolenkow, 2014, Cambridge University Press.
3) Mechanics Berkeley Physics Course, Vol. 1, 2/e: Charles Kittel, et. al., 2017, McGraw Hill Education
4) Mechanics, D. S. Mathur, P. S. Hemne, 2012, S. Chand.
5) Intermediate Dynamics, Patrick Hamill, 2010, Jones and Bartlett Publishers.

Additional Readings:

1) Feynman Lectures, Vol. 1, R. P. Feynman, R. B. Leighton, M. Sands, 2008, Pearson Education.
2) University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
3) University Physics, H. D. Young, R. A. Freedman, 14/e, 2015, Pearson Education.
4) Fundamentals of Physics, Resnick, Halliday and Walker 10/e, 2013, Wiley.
5) Engineering Mechanics, Basudeb Bhattacharya, 2/e, 2015, Oxford University Press.
6) Physics for Scientists and Engineers, Randall D Knight, 3/e, 2016, Pearson Education.

PRACTICAL COMPONENT (60 Hours)

The teacher is expected to give basic idea and working of various apparatus and instruments related to different experiments. Students should also be given knowledge of recording and analysing experimental data.

Every student should perform at least 06 experiments from the following list.

1) Measurement of length (or diameter) using vernier calliper, screw gauge and travelling microscope.
2) Study the random error in observations.
3) Determination of height of a building using a sextant.
4) Study of motion of the spring and calculate (a) spring constant and, (b) acceleration due to gravity
5) Determination of moment of inertia of a flywheel.
6) Determination of g and velocity for a freely falling body using digital timing technique.
7) Determination of modulus of rigidity of a wire using Maxwell's needle.
8) Determination of elastic constants of a wire by Searle's method.
9) Determination of value of g using bar pendulum.
10) Determination of value of g using Kater's pendulum.

References (for Laboratory Work):

1) Advanced Practical Physics for students, B. L. Flint and H. T. Worsnop, 1971, Asia Publishing House.
2) Engineering Practical Physics, S. Panigrahi and B. Mallick, 2015, Cengage Learning India Pvt. Ltd.
3) Practical Physics, G. L. Squires, 2015, 4/e, Cambridge University Press.
4) A Textbook of Practical Physics, I. Prakash and Ramakrishna, 11/e, 2011, Kitab Mahal.
5) B. Sc. Practical Physics, Geeta Sanon, R. Chand and Co., 2016.

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

DISCIPLINE SPECIFIC CORE COURSE – 2 (DSC - 2)
Network Analysis and Analog Electronics

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Network Analysis and Analog Electronics Physics DSC 2	4	2	0	2	Class XII pass with Physics and Mathematics as main subjects	Physics and Mathematics syllabus of class XII

Learning Objectives

This course offers the basic knowledge to students to design and analyse the network circuit analysis and analog electronics. It gives the concept of voltage, current sources and various electrical network theorems, physics of semiconductor devices including junction diode, bipolar junction transistors, unipolar devices and their applications are discussed in detail. This also develops the understanding of amplifier and its applications.

Learning Outcomes

At the end of this course, students will be able to achieve the following learning outcomes.

- To understand the concept of voltage and current sources, Network theorems, Mesh Analysis.
- To develop an understanding of the basic operation and characteristics of different type of diodes and familiarity with its working and applications.
- Become familiar with Half-wave, Full-wave centre tapped and bridge rectifiers. To be able to calculate ripple factor and efficiency.
- To be able to recognize and explain the characteristics of a PNP or NPN transistor.
- Become familiar with the load-line analysis of the BJT configurations and understand the hybrid model (h- parameters) of the BJT transistors.
- To be able to perform small signal analysis of Amplifier and understand its classification.
- To be able to perform analysis of two stage R-C coupled Amplifier.
- To understand the concept of positive and negative feedback along with applications in case of oscillators.
- To become familiar with construction, working and characteristics of JFET and UJT.

SYLLABUS OF PHYSICS DSC – 2

THEORY COMPONENT

Unit 1: (8 Hours)

Circuit Analysis: Concept of Voltage and Current Sources (ideal and practical). Kirchhoff’s Laws. Mesh Analysis, Node Analysis. Star and Delta networks and their Conversion Superposition Theorem. Thevenin’s Theorem. Norton’s Theorem. Reciprocity Theorem. Maximum Power Transfer Theorem.

Unit 2: (5 Hours)

Semiconductor Diode: PN junction diode (Ideal and practical), Diode equation (Qualitative only) and I-V characteristics. Idea of static and dynamic resistance, Zener diode working. Rectifiers: Half wave rectifier (Qualitative only), Full wave rectifiers (center tapped and bridge): circuit diagrams, working and waveforms, ripple factor and efficiency.
Filter circuits: Shunt capacitance and series Inductance filter (no derivation).
Regulation: Zener diode as voltage regulator for load and line regulation.

Unit 3: (7 Hours)

Bipolar Junction Transistor: Review of the characteristics of transistor in CE and CB configurations, Regions of operation (active, cut off and saturation), Current gains α and β. Relations between α and β. dc load line and Q point.

Amplifiers: Transistor biasing and Stabilization circuits - Voltage Divider Bias. Thermal runaway, stability (Qualitative only). Transistor as a two-port network, h-parameter equivalent circuit. Small signal analysis of single stage CE amplifier. Input and Output impedance, Current and Voltage gains. Class A, B and C Amplifiers.

Unit 4: (10 Hours)

Cascaded Amplifiers: Two stage RC Coupled Amplifier and its frequency response.
Sinusoidal Oscillators: Concept of feedback (negative and positive feedback), Barkhausen criterion for sustained oscillations. Phase shift and Colpitt's oscillator. Determination of frequency and condition of oscillation
Unipolar Devices: JFET. Construction, working and I-V characteristics (output and transfer), Pinch-off voltage. UJT, basic construction, working, equivalent circuit and I-V characteristics. UJT Oscillator.

References:

Essential Readings:

1) Network, Lines and Fields, J. D. Ryder, Prentice Hall of India
2) Integrated Electronics, J. Millman and C.C. Halkias, Tata Mcgraw Hill (2001)
3) Electric Circuits , S. A. Nasar, Schaum Outline Series, Tata McGraw Hill (2004)
4) Electric Circuits, K.A. Smith and R. E. Alley, Cambridge University Press(2014)
5) 2000 Solved Problems in Electronics, J. J. Cathey, Schaum Outline Series, Tata McGraw Hill (1991)

Additional Readings:

1) Microelectronic Circuit, A. S. Sedra, K.C. Smith, A. N. Chandorkar, 6th Edition (2014), Oxford University Press
2) Electronic Circuits: Discreet and Integrated, D. L. Schilling and C. Belove, Tata McGraw Hill.
3) Electronic Devices and Circuits, David A. Bell, 5th Edition 2015, Oxford University Press.
4) Electrical Circuits, M. Nahvi and J. Edminister, Schaum Outline Series, Tata McGraw Hill (2005)

PRACTICAL COMPONENT (60 Hours)

At least 06 experiments from the following.

1) To familiarize with basic electronic components (R, L, C, diodes, transistors), digital Multimeter, Function Generator and Oscilloscope
2) Verification of
    a. Thevenin's theorem and
    b. Norton's theorem.
3) Verification of
    a. Superposition Theorem and
    b. Reciprocity Theorem
4) Verification of the Maximum Power Transfer Theorem.
5) Study of the I-V Characteristics of
    a. p-n junction Diode, and
    b. Zener diode.

6) Study of
    a. Half wave rectifier and
    b. Full wave rectifier (FWR).
7) Study the effect of
    a. C- filter and L- filter and
    b. Zener regulator.
8) Study of the I-V Characteristics of UJT and design relaxation oscillator.
9) Study of the output and transfer I-V characteristics of common source JFET.
10) Study of Voltage divider bias configuration for CE transistor.
11) Design of a Single Stage CE amplifier of given gain.
12) Study of the RC Phase Shift Oscillator.

References (For Laboratory Work):

1) Electronic Devices and Circuits, Allen Mottershead, Goodyear Publishing Corporation.
2) Electrical Circuits, M. Nahvi and J. Edminister, Schaum Outline Series, Tata McGraw Hill (2005)
3) Network, Lines and Fields, J. D. Ryder, Prentice Hall of India
4) Integrated Electronics, J. Millman and C.C. Halkias, Tata Mcgraw Hill (2001)

BSc. (HONOURS)
IN ANALYTICAL CHEMISTRY
&
IN INDUSTRIAL CHEMISTRY
Multidisciplinary

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Mechanics DSC - 1	4	2	0	2	Class XII pass with Physics and Mathematics as main subjects	Physics and Mathematics syllabus of class XII

Learning Objectives
This course reviews the concepts of mechanics learnt at school from a more advanced perspective and goes on to build new concepts. It begins with a review of vector algebra and ordinary differential equations. The students will learn Newton's laws of motion, conservation of momentum, conservation of energy, concept of simple harmonic motion, Newton's laws of gravitation, elasticity and the Special Theory of Relativity. They will be able to apply the concepts learnt to several real world problems.

Learning Outcomes
Upon completion of this course, students will be able to,
- Learn the laws of motion and their application to various dynamical situations.
- Understand the concept of conservation of momentum, angular momentum and energy. Their application to basic problems.
- Understand the motion of simple pendulum
- Understand the laws of gravitation and basic idea of global positioning system
- Understand the elastic properties
- Postulates of special theory of relativity, inertial and non-inertial frame of reference and their transformation, relativistic effects on the mass and energy of a moving body.

SYLLABUS OF DSC – 1

Vectors: Review of vector algebra. Scalar and vector product

(2 Hours)

Ordinary Differential Equations: First order homogeneous differential equations, second order homogeneous differential equation with constant coefficients

(4 Hours)

Brief review of Newton's laws of motion, dynamics of a system of particles, centre of mass, determination of centre of mass for continuous systems having spherical symmetry. Conservation of momentum and energy, work – energy theorem for conservative forces, force as a gradient of potential energy, angular momentum, torque, conservation of angular momentum

(9 Hours)

Idea of simple harmonic motion, differential equation of simple harmonic motion and its solution, kinetic energy and potential energy, total energy and their time average for a body executing simple harmonic motion

(4 Hours)

Newton's law of gravitation, motion of a particle in a central force field, Kepler's laws,weightlessness, geosynchronous orbit, basic idea of global positioning system

(4 Hours)

Elasticity: Concept of stress and strain, Hooke's law, elastic moduli, twisting torque on awire, tensile strength, relation between elastic constants, Poisson's ratio, rigidity modulus

(3 Hours)

Postulates of special theory of relativity, Lorentz transformation relations, length contraction,time dilation, relativistic transformation of velocity

(4 Hours)

PRACTICAL COMPONENT (60 Hours)

Every student should perform at least 06 experiments from the following list.

1) Measurements of length (or diameter) using vernier calliper, screw gauge and travellingmicroscope.
2) Determination of height of a building using a sextant.
3) Study of motion of the spring and calculate (a) spring constant and, (b) acceleration dueto gravity (g)
4) Determination of moment of inertia of a flywheel.
5) Determination of Young's modulus of a wire by Optical Lever Method.
6) Determination of modulus of rigidity of a wire using Maxwell's needle.
7) Determination of elastic constants of a wire by Searle's method.
8) Determination of value of g using bar pendulum.
9) Determination of value of g using Kater's pendulum.

References (for Laboratory Work):

1) Advanced practical physics for students, B. L. Flint and H. T. Worsnop, 1971, AsiaPublishing House.
2) Engineering practical physics, S. Panigrahi and B. Mallick, 2015, Cengage Learning India
3) Practical physics, G. L. Squires, 2015, 4/e, Cambridge University Press.
4) A text book of practical physics, I. Prakash and Ramakrishna, 11/e, 2011, Kitab Mahal.
5) B. Sc. practical physics, Geeta Sanon, R. Chand, 2016

Essential Readings:

FOR THEORY COMPONENT

1) Schaum's Outline of Vector Analysis, 2nd Edn., Murray Spiegel, Seymour Lipschutz,Tata McGraw-Hill, (2009)
2) An Introduction to Mechanics (2/e), Daniel Kleppner and Robert Kolenkow, 2014, Cambridge University Press.
3) Mechanics Berkeley Physics Course, Vol. 1, 2/e, Charles Kittel, et. al., 2017, McGrawHill Education
4) Mechanics, D. S. Mathur and P. S. Hemne, 2012, S. Chand.

.**Suggestive Readings:**

1) University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
2) University Physics, H. D. Young and R. A. Freedman, 14/e, 2015, Pearson Education.
3) Fundamentals of Physics, Resnick, Halliday and Walker 10/e, 2013, Wiley.
4) Engineering Mechanics, Basudeb Bhattacharya, 2/e, 2015, Oxford University Press.

COMMON POOL OF GENERIC ELECTIVES (GE) COURSES
Offered by Department of Physics
Category-IV

COMMON POOL OF GENERIC ELECTIVES (GE) COURSES

Note: E xamination s cheme a nd m ode s hall be a s pr escribed by t he E xamination Branch, University of Delhi, from time to time.

GENERIC ELECTIVES (GE – 1): MECHANICS

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course	Department offering the course
		Lecture	Tutorial	Practical/ Practice			
Mechanics GE 1	4	3	0	1	Class XII pass	NIL	Physics and Astrophysics

Learning Objectives

This course reviews the concepts of mechanics learnt at school in a more advanced perspective and goes on to build new concepts. It begins with dynamics of a system of particles and ends with the special theory of relativity. Students will appreciate the concept of rotational motion, gravitation and oscillations. The students will be able to apply the concepts learnt to several real world problems. A brief recapitulation of vector algebra and differential equations is also done to familiarize students with basic mathematical concepts which are necessary for a course on mechanics.

Learning Outcomes

Upon completion of this course, students are expected to understand the following concepts.

- Laws of motion and their application to various dynamical situations. And their applications to conservation of momentum, angular momentum and energy.
- Motion of a simple and compound pendulum
- Application of Kepler's laws to describe the motion of satellites in circular orbit.
- The concept of geosynchronous orbits
- Concept of stress and strain and relation between elastic constants
- Postulates of Special Theory of Relativity, Lorentz transformation, relativistic effects on the mass and energy of a moving body.

In the laboratory course, after acquiring knowledge of how to handle measuring instruments (like vernier calliper, screw gauge and travelling microscope) student shall embark on verifying various principles and associated measurable quantities.

SYLLABUS OF GE – 1

THEORY COMPONENT

Unit 1: Recapitulation of Vectors and Ordinary Differential Equation (8 Hours)

Vector algebra, scalar and vector product, gradient of a scalar field, divergence and curl of vectors field

Ordinary Differential Equations: First order homogeneous differential equations, second order homogeneous differential equation with constant coefficients

Unit 2: Fundamentals of Dynamics (10 Hours)

Review of Newton's laws of motion, dynamics of a system of particles, centre of mass, determination of centre of mass for discrete and continuous systems having spherical symmetry, Conservation of momentum and energy, Conservative and non-Conservative forces, work – energy theorem for conservative forces, force as a gradient of potential energy.

Unit 3: Rotational Dynamics and Oscillatory Motion (14 Hours)

Angular velocity, angular momentum, torque, conservation of angular momentum, Moment of inertia, Theorem of parallel and perpendicular axes, Calculation of moment of inertia of discrete and continuous objects (1-D and 2-D).

Idea of simple harmonic motion, Differential equation of simple harmonic motion and its solution, Motion of a simple pendulum and compound pendulum

Unit 4: Gravitation (5 Hours)

Newton's Law of Gravitation, Motion of a particle in a central force field, Kepler's Laws (statements only), Satellite in circular orbit and applications, geosynchronous orbits

Unit 5: Elasticity (3 Hours)

Concept of stress and strain, Hooke's law, elastic moduli, twisting torque on a wire, tensile strength, relation between elastic constants, Poisson's ratio, rigidity modulus

Unit 6: Special Theory of Relativity (5 Hours)

Postulates of Special Theory of Relativity, Lorentz transformation, length contraction, time dilation, relativistic transformation of velocity, relativistic variation of mass, mass-energy equivalence

PRACTICAL COMPONENT (30 Hours)

The teacher is expected to give basic idea and working of various apparatus and instruments related to different experiments. Students should also be given knowledge of recording and analyzing experimental data.

Every student should perform at least 06 experiments from the following list.

1) Measurement of length (or diameter) using vernier calliper, screw gauge and travelling microscope.
2) Study the random error in observations.
3) Determination of height of a building using a sextant.
4) Study of motion of the spring and calculate (a) spring constant and, (b) acceleration due to gravity (g)
5) Determination of moment of inertia of a flywheel.
6) Determination of g and velocity for a freely falling body using digital timing technique.
7) Determination of modulus of rigidity of a wire using Maxwell's needle.
8) Determination of elastic constants of a wire by Searle's method.
9) Determination of value of g using bar pendulum.
10) Determination of value of g using Kater's pendulum.

References (for Laboratory Work):

1) Advanced practical physics for students, B. L. Flint and H. T. Worsnop, 1971, Asia Publishing House.
2) Engineering practical physics, S. Panigrahi and B. Mallick, 2015, Cengage Learning India Pvt. Ltd.
3) Practical physics, G. L. Squires, 2015, 4/e, Cambridge University Press.
4) A text book of practical physics, I. Prakash and Ramakrishna, 11/e, 2011, Kitab Mahal.
5) B. Sc. practical physics, Geeta Sanon, R. Chand and Co., 2016.

Essential readings:

FOR THEORY COMPONENT

1) Vector Analysis – Schaum's Outline, M.R. Spiegel, S. Lipschutz, D. Spellman, 2nd Edn., 2009, McGraw- Hill Education.
2) An Introduction to Mechanics (2/e), Daniel Kleppner and Robert Kolenkow, 2014, Cambridge University Press.
3) Mechanics Berkeley Physics Course, Vol. 1, 2/e: Charles Kittel, et. al., 2017, McGraw Hill Education
4) Mechanics, D. S. Mathur, P. S. Hemne, 2012, S. Chand.
5) Fundamentals of Physics, Resnick, Halliday and Walker 10/e, 2013, Wiley.

Suggestive readings

1) Feynman Lectures, Vol. 1, R. P. Feynman, R. B. Leighton, M. Sands, 2008, Pearson Education.
2) University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
3) University Physics, H. D. Young, R. A. Freedman, 14/e, 2015, Pearson Education.
4) Engineering Mechanics, Basudeb Bhattacharya, 2/e, 2015, Oxford University Press
5) Physics for Scientists and Engineers, Randall D Knight, 3/e, 2016, Pearson Education.

GENERIC ELECTIVES (GE - 2): MATHEMATICAL PHYSICS

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Mathematical Physics GE – 2	4	3	1	0	Class XII pass	NIL

Learning Objectives

The emphasis of course is to equip students with the mathematical tools required in solving problem of interest to physicists. The course will expose students to fundamental computational physics skills and hence enable them to solve a wide range of physics problems.

Learning Outcomes

At the end of this course, the students will be able to,

- Understand functions of several variables.
- Represent a periodic function by a sum of harmonics using Fourier series and their applications in physical problems such as vibrating strings etc.
- Obtain power series solution of differential equation of second order with variable coefficient using Frobenius method.
- Understand properties and applications of special functions like Legendre polynomials, Bessel functions and their differential equations and apply these to various physical problems such as in quantum mechanics.
- Learn about gamma and beta functions and their applications.
- Solve linear partial differential equations of second order with separation of variable method.
- Understand the basic concepts of complex analysis and integration.
- During the tutorial classes, students' skill will be developed to solve more problems related to the concerned topics.

SYLLABUS OF GE – 2

THEORY COMPONENT

Unit 1: **(6 Hours)**

Fourier s eries: Periodic functions. Orthogonality of sine and cosine functions, Convergence of Fourier series and Dirichlet Conditions (Statement only). Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients. Even and odd functions and their Fourier expansions (Fourier Cosine Series and Fourier Sine Series).

Unit 2: (10 Hours)

Frobenius Method and Special Functions: Singular Points of Second Order Linear Differential Equations and their importance. Frobenius method and its applications to differential equations. Legendre and Bessel Differential Equations.

Unit 3: (14 Hours)

Some Special Integrals: Beta and Gamma Functions and Relation between them. Expression of integrals in terms of Gamma Functions.

Partial Differential Equations: Multivariable functions, Partial derivatives, Functions Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular geometry, Solution of 1D wave equation.

Unit 4: (15 Hours)

Complex Analysis: Functions of complex variable, limit, continuity, Analytic function, Cauchy-Riemann equations, singular points, Cauchy Goursat Theorem, Cauchy's Integral Formula, Residues, Cauchy's Residue Theorem.

Essential readings:

1) Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.
2) Complex Variables and Applications, J. W. Brown and R. V. Churchill, 7th Ed. 2003, Tata McGraw-Hill
3) Advanced Mathematics for Engineers and Scientists: Schaum Outline Series, M. R Spiegel, 2009, McGraw Hill Education.
4) Applied Mathematics for Engineers and Physicists, L.A. Pipes and L.R. Harvill, 2014, Dover Publications.
5) Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd Ed., 2006, Cambridge University Press.

Suggestive readings

1) Mathematical Physics, A. K. Ghatak, I. C. Goyal and S. J. Chua, 2017, Laxmi Publications Private Limited.
2) Advanced Engineering Mathematics, D. G. Zill and W. S. Wright, 5 Ed., 2012, Jones and Bartlett Learning.
3) An introduction to ordinary differential equations, E. A. Coddington, 2009, PHI Learning.
4) Differential Equations, George F. Simmons, 2007, McGraw Hill.
5) Mathematical methods for Scientists and Engineers, D. A. Mc Quarrie, 2003, Viva Books

GENERIC ELECTIVES (GE – 3): WAVES AND OPTICS

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Waves and Optics GE 3	4	3	0	1	Class XII pass	NIL

Learning Objectives

This coursework reviews the concept of waves and optics learnt at school level from a more advanced perspective and builds new concepts. This course is divided into two main parts. The first part deals with vibrations and waves. The second part pertains to optics and provides the details of interference, diffraction and polarization.

Learning Outcomes

After the completion of this course, the students will have learnt the following.

- Simple harmonic motion, superposition principle and its application to find the resultant of superposition of harmonic oscillations.
- Concepts of vibrations in strings.
- Interference as superposition of waves from coherent sources.
- Basic concepts of Diffraction: Fraunhoffer and Fresnel Diffraction.
- Elementary concepts of the polarization of light.

SYLLABUS OF GE – 3

THEORY COMPONENT

Unit 1: **(10 Hours)**

Superposition of Harmonic Oscillations: Simple harmonic motion (SHM). Linearity and Superposition Principle. Superposition of two collinear harmonic oscillations having (1) equal frequencies and (2) different frequencies (Beats). Superposition of two perpendicular harmonic oscillations: Graphical and Analytical Methods. Lissajous Figures (1:1 and 1:2) and their uses.

Unit 2: **(5 Hours)**

Waves Motion: Types of waves: Longitudinal and Transverse (General idea). Travelling waves in a string, wave equation. Energy density. Standing waves in a string - modes of vibration. Phase velocity.

Unit 3: **(12 Hours)**
Interference of Light: Electromagnetic nature of light. Definition and properties of wave front. Huygens Principle. Interference: Division of amplitude and division of wave front. Young's Double Slit experiment. Fresnel's Biprism. Phase change on reflection: Stoke's treatment. Interference in Thin Films: parallel and wedge-shaped films. Newton's Rings: measurement of wavelength and refractive index.

Unit 4: **(12 Hours)**
Diffraction: Fraunhofer diffraction - Single slit, Double slit and Diffraction grating. Fresnel Diffraction - Half-period zones, Zone plate, Fresnel Diffraction pattern of a straight edge using half-period zone analysis.

Unit 5: **(6 Hours)**
Polarization: Transverse nature of light waves. Plane polarized light. Production and detection of linearly polarized light. Malus's Law. Idea of circular and elliptical polarization.

PRACTICAL COMPONENT **(30 Hours)**

Every student must perform at least 05 experiments out of the list following experiments.

1) To determine the frequency of an electrically maintained tuning fork by Melde's experiment and to verify λ^2 – T Law.
2) To study Lissajous Figures.
3) Familiarization with Schuster`s focusing and determination of the angle of prism.
4) To determine the refractive index of the material of a prism using sodium light.
5) To determine the dispersive power of a prism using mercury light.
6) To determine wavelength of sodium light using Newton's rings.
7) To determine wavelength of sodium light using a plane diffraction grating.
8) To verify Malus's Law.
9) To determine the wavelength of Laser light using single slit diffraction. (Due care should be taken not to see Laser light source directly as it may cause injury to eyes.)

References (for Laboratory Work):

1) Advanced Practical Physics for students, B. L. Flint and H. T. Worsnop, Asia Publishing House
2) A Text Book of Practical Physics, Indu Prakash and Ramakrishna, Kitab Mahal
3) An advanced course in practical physics, D. Chattopadhyay and P. C. Rakshit, New Central Book Agency

Essential readings:

FOR THEORY COMPONENT

1) The Physics of Waves and Oscillations: N K Bajaj, Tata Mcgraw Hill
2) Optics: Ajoy Ghatak, Seventh edition, Mcgraw Hill
3) Principle of Optics: B. K. Mathur and T. P. Pandya, Gopal Printing Press
4) Optics: Brij Lal and N. Subramanyam, S. Chand
5) The Fundamentals of Optics: A. Kumar, H. R. Gulati and D. R. Khanna, R. Chand

Suggestive readings:

1) Vibrations and Waves: A. P. French, CRC
2) The physics of Vibrations and Waves: H. J. Pain, Wiley
3) Fundamentals of Optics: Jenkins and White, McGraw Hill
4) Optics: E. Hecht and A R. Ganesan, Pearson, India
5) Introduction to Optics: F. Pedrotti, L. M. Pedrotti and L. S. Pedrotti, Pearson, India

GENERIC ELECTIVES (GE - 6): INTRODUCTORY ASTRONOMY

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Introductory Astronomy GE 6	4	3	1	0	Class XII pass	NIL

Learning Objectives

This course is meant to introduce undergraduate students to the wonders of the Universe. Students will understand how astronomers over millennia have come to understand mysteries of the universe using laws of geometry and physics, and more recently chemistry and biology. They will be introduced to the Indian contribution to astronomy starting from ancient times up to the modern era. They will learn about diverse set of astronomical phenomenon, from the daily and yearly motion of stars and planets in the night sky which they can observe themselves, to the expansion of the universe deduced from the latest observations and cosmological models. Students will also be introduced to internet astronomy and the citizen science research platform in astronomy. The course presupposes school level understanding of mathematics and physics.

Learning Outcomes

- After completing this course, student will gain an understanding of,
- Different types of telescopes, diurnal and yearly motion of astronomical objects, astronomical coordinate systems and their transformations
- Brightness scale for stars, types of stars, their structure and evolution on HR diagram
- Components of solar system and its evolution
- Current research in detection of exoplanets
- Basic structure of different galaxies and rotation of the Milky Way galaxy
- Distribution of chemical compounds in the interstellar medium and astrophysical conditions necessary for the emergence and existence of life
- Internet based astronomy and the collaborative citizen astronomy projects

- India’s contribution to astronomy, both in ancient times and in modern era.

SYLLABUS OF GE – 6

Unit 1: (8 Hours)
Introduction to Astronomy and Astronomical Scales: History of astronomy, wonders of the Universe, overview of the night sky, diurnal and yearly motions of the Sun, size, mass, density and temperature of astronomical objects, basic concepts of positional astronomy: Celestial sphere, Astronomical coordinate systems, Horizon system and Equatorial system

Unit 2: (6 Hours)
Basic Parameters of Stars: Stellar energy sources, determination of distance by parallax method, aberration, proper motion, brightness, radiant flux and luminosity, apparent and absolute magnitude scales, distance modulus, determination of stellar temperature and radius, basic results of Saha ionization formula and its applications for stellar astrophysics, stellar spectra, dependence of spectral types on temperature, luminosity classification, stellar evolutionary track on Hertzsprung-Russell diagram

Unit 3: (8 Hours)
Astronomical Instruments: Observing through the atmosphere (Scintillation, Seeing, Atmospheric Windows and Extinction). Basic Optical Definitions for Telescopes: Magnification, Light Gathering Power, Limiting magnitude, Resolving Power, Diffraction Limit. Optical telescopes, radio telescopes, Hubble space telescope, James Web space telescope, Fermi Gamma ray space telescope.
Astronomy in the Internet Age: Overview of Aladin Sky Atlas, Astrometrica, Sloan Digital Sky Survey, Stellarium, virtual telescope
Citizen Science Initiatives: Galaxy Zoo, SETI@Home, RAD@Home India

Unit 4: (8 Hours)
Sun and the solar system: Solar parameters, Sun’s internal structure, solar photosphere, solar atmosphere, chromosphere, corona, solar activity, origin of the solar system, the nebular model, tidal forces and planetary rings
Exoplanets: Detection methods and characterization

Unit 5: (12 Hours)
Physics of Galaxies: Basic structure and properties of different types of Galaxies, Nature of rotation of the Milky Way (Differential rotation of the Galaxy), Idea of dark matter
Cosmology and Astrobiology: Standard Candles (Cepheids and SNe Type1a), Cosmic distance ladder, Olber’s paradox, Hubble’s expansion, History of the Universe, Chemistry of life, Origin of life, Chances of life in the solar system

Unit 6: (4 Hours)
Astronomy in India: Astronomy in ancient, medieval and early telescopic era of India, current Indian observatories (Hanle-Indian Astronomical Observatory, Devasthal Observatory, Vainu Bappu Observatory, Mount Abu Infrared Observatory, Gauribidanur Radio Observatory, Giant Metre-wave Radio Telescope, Udaipur Solar Observatory, LIGO -

India) (qualitative discussion), Indian astronomy missions (Astrosat, Aditya)

Essential readings:

1) Seven Wonders of the Cosmos, Jayant V Narlikar, Cambridge University Press
2) Fundamental of Astronomy, H. Karttunen et al. Springer
3) Modern Astrophysics, B.W. Carroll and D.A. Ostlie, Addison-Wesley Publishing Co.
4) Introductory Astronomy and Astrophysics, M. Zeilik and S.A. Gregory, Saunders College Publishing.
5) The Molecular Universe, A.G.G.M. Tielens (Sections I, II and III), Reviews of Modern Physics, Volume 85, July-September, 2013
6) Astronomy in India: A Historical Perspective, Thanu Padmanabhan, Springer

Useful websites for astronomy education and citizen science research platform

1) https://aladin.u-strasbg.fr/
2) http://www.astrometrica.at/
3) https://www.sdss.org/
4) http://stellarium.org/
5) https://www.zooniverse.org/projects/zookeeper/galaxy-zoo/
6) https://setiathome.berkeley.edu/
7) https://www.radathomeindia.org/

Suggestive readings:

1) Explorations: Introduction to Astronomy, Thomos Arny and Stephen Schneider, McGraw Hill
2) Astrophysics Stars and Galaxies K D Abhyankar, Universities Press
3) Textbook of Astronomy and Astrophysics with elements of cosmology, V.B. Bhatia, Narosa Publication.
4) Baidyanath Basu, An introduction to Astrophysics, Prentice Hall of India Private Limited.
5) The Physical Universe: An Introduction to Astronomy, F H Shu, University Science Books

DEPARTMENT OF CHEMISTRY

BSc. (Hons.) Chemistry

Category-I

DISCIPLINE SPECIFIC CORE COURSE -1 (DSC-1): Atomic Structure & Chemical Bonding

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course t itle & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite o f the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Atomic Structure & Chemical Bonding (DSC-1: Inorganic Chemistry -I)	04	03	—	01	Physics, Chemistry, Mathematics	--

Learning Objectives

The course reviews the structure of the atom, which is a necessary pre-requisite in understanding the nature of chemical bonding in compounds. It provides basic knowledge about ionic and covalent bonding, and explains that chemical bonding is best regarded as a continuum between the two cases. It discusses the periodicity in properties with reference to the s and p block, which is necessary in understanding their group chemistry. The student will also learn about the fundamentals of acid-base and redox titrimetric analysis.

Learning outcomes

By the end of the course, the students will be able to:

- Solve the conceptual questions using the knowledge gained by studying the quantum mechanical model of the atom, quantum numbers, electronic configuration, radial and angular distribution curves, shapes of s, p, and d orbitals, and periodicity in atomic radii, ionic radii, ionization enthalpy and electron affinity of elements.
- Draw the plausible structures and geometries of molecules using radius ratio rules, VSEPR theory and MO diagrams (homo- & hetero-nuclear diatomic molecules).
- Understand the concept of lattice energy using Born-Landé and Kapustinskii equation.
- Calibrate the apparatus used in titrimetric analysis and prepare standard solutions for titration
- Understand the theory and application of various acid-base and redox titrations.
- Comprehend the theory of acid-base indicators

SYLLABUS OF DSC-1

UNIT – I (15 Hours)
Unit 1: Atomic Structure

Recapitulation of concept of atom in ancient India, Bohr's theory & its limitations, atomic spectrum of hydrogen atom.

de Broglie equation, Heisenberg's Uncertainty Principle and its significance. Postulates of wave mechanics, Time independent Schrödinger's wave equation, well behaved wave function, significance of ψ and ψ^2. Quantum mechanical treatment of H- atom, Quantum numbers and their significance. Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wave functions for hydrogen atom. Radial function plots, radial probability distribution plots, angular distribution curves. Shapes of *s*, *p*, and *d* orbitals, Relative energies of orbitals.

Pauli's Exclusion Principle, Hund's rule of maximum spin multiplicity, Aufbau principle and its limitations.

UNIT – II (6 Hours)

Unit 2: Periodic properties of Elements & Periodic Trends

Brief discussion of the following properties of the elements, with reference to *s*- & *p*-block andtheir trends:

(a) Effective nuclear charge, shielding or screening effect and Slater's rules

(b) Atomic and ionic radii

(c) Ionization enthalpy (Successive ionization enthalpies)

(d) Electron gain enthalpy

(e) Electronegativity, Pauling's scale of electronegativity. Variation of electronegativity with bond order and hybridization.

UNIT – III (12 Hours)

Unit 3: Ionic bond

General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Lattice energy, Born-Landé equation with derivation, Madelung constant, importance of Kapustinskii equation for lattice energy. Born-Haber cycle and its applications.

Covalent character in ionic compounds, polarizing power and polarizability. Fajan's rules and consequences of polarization.

UNIT – IV (12 Hours)
Unit 4: Covalent bond
Valence shell electron pair repulsion (VSEPR) theory, shapes of the following simple molecules and ions containing lone pairs and bond pairs of electrons: H_2O, NH_3, PCl_3, PCl_5,

SF_6, ClF_3, I_3, BrF_2^+, PCl_6^-, ICl_2^- ICl_4^-, and SO_4^{2-}. Application of VSEPR theory in predicting trends in bond lengths and bond angles.

Valence Bond theory (*Heitler-London* approach). Hybridization, equivalent and non-equivalent hybrid orbitals, Bent's rule.

Ionic character in covalent compounds: Bond moment and dipole moment. Percentage ionic character from dipole moment and electronegativity difference.

Molecular orbital diagrams of homo & hetero diatomic molecules [N_2, O_2, C_2, B_2, F_2, CO, NO] and their ions; HCl (idea of s-p mixing and orbital interaction to be given).

Practical component
Practicals: Inorganic Chemistry-I **(30 Hours)**

(Laboratory periods: 15 classes of 2 hours each)

1. **Titrimetric Analysis:**
   (i) Calibration and use of apparatus
   (ii) Preparation of solutions ofdifferent Molarity/Normality.

2. **Acid-Base Titrations:** Principles of acid-base titrations to be discussed.
(i) Estimation of oxalic acid using standardized NaOH solution
(ii) Estimation of sodium carbonate using standardized HCl.
(iii) Estimation of carbonate and hydroxide present together in a mixture.
(iv) Estimation of carbonate and bicarbonate present together in a mixture.

3. **Redox Titration:** Principles of oxidation-reduction titrations to be discussed.
(i) Estimation of oxalic acid using standardized $KMnO_4$ solution
(ii) Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.
(iii) Estimation of oxalic acid and sodium oxalate in a given mixture.

Essential/recommended readings
References:
Theory :

1. Lee, J.D. (2010), **Concise Inorganic Chemistry**, Wiley India.
2. Huheey, J.E.; Keiter, E.A.; Keiter; R. L.; Medhi, O.K. (2009), **Inorganic Chemistry-Principles of Structure and Reactivity**, Pearson Education.
3. Douglas, B.E.; McDaniel, D.H.; Alexander, J.J. (1994), **Concepts and Models of Inorganic Chemistry**, John Wiley & Sons.
4. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A. (2010), **Shriver and Atkins Inorganic Chemistry**, 5th Edition, Oxford University Press.
5. Pfennig, B. W. (2015), **Principles of Inorganic Chemistry.** John Wiley & Sons.
6. Housecraft, C. E.; Sharpe, A. G., (2018), Inorganic Chemistry, 5th Edition, Pearson.
7. Wulfsberg, G (2002), **Inorganic Chemistry,** Viva Books Private Limited.
8. Miessler, G.L.; Fischer P.J.; Tarr, D. A. (2014), **Inorganic Chemistry**, 5th Edition, Pearson.

9. Shiver, D.; Weller, M.; Overton, T.; Rourke, J.; Armstrong, F. (2014), **Inorganic Chemistry**, 6th Edition, Freeman & Company
10. Das, A. K.; Das, M. (2014), **Fundamental Concepts of Inorganic Chemistry**, 1st Edition, Volume CBS Publishers & Distributors Pvt. Ltd.

Practicals:

1. Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C. (1989), Vogel's Textbook of **Quantitative Chemical Analysis,** John Wiley and Sons.
2. Harris, D. C.; Lucy,C. A.(2016), **Quantitative Chemical Analysis,** 9th Edition, Freeman andCompany

Note: E xamination s cheme a nd m ode s hall be a s pr escribed by t he E xamination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 2 (DSC-2): Basic Concepts and Aliphatic Hydrocarbons

Credit distribution, Eligibility and Prerequisites of the Course

Course t itle & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Basic Concepts and Aliphatic Hydrocarbons (DSC-2: Organic Chemistry-I)	**04**	**03**	**--**	**01**	Physics, Chemistry, Mathematics	**--**

Learning Objectives

The core course Organic Chemistry I is designed in a manner that it forms a cardinal part of the learning of organic chemistry for the subsequent semesters. The course is infused with the recapitulation of fundamental concepts of organic chemistry and the introduction of the concept of visualizing the organic molecules in a three-dimensional space. To establish the applications of these concepts, the functional groups-alkanes, alkenes, alkynes are introduced. The constitution of the course strongly aids in the paramount learning of the concepts and their applications.

Learning outcomes

On completion of the course, the student will be able to:

- Understand and explain the electronic displacements and reactive intermediates and their applications in basic concepts.
- Formulate the mechanistic route of organic reactions by recalling and correlating the fundamental concepts.

- Identify and comprehend mechanism for free radical substitution, electrophilic addition, nucleophilic substitution and elimination reactions.
- Understand the fundamental concepts of stereochemistry.
- Understand and suitably use the chemistry of hydrocarbons

SYLLABUS OF DSC- 2

UNIT – I (9 Hours)
Unit I: Basic Concepts of Organic Chemistry

Electronic displacements and their applications: inductive, electromeric, resonance and mesomeric effects and hyperconjugation. Dipole moment, acidity and basicity.

Homolytic and heterolytic fissions with suitable examples. Types, shape and relative stability of carbocations, carbanions, carbenes and free radicals.

Electrophiles & nucleophiles, and introduction to types of organic reactions: addition, elimination and substitution reactions.

UNIT – II (18 Hours)
Unit II: Stereochemistry

Stereoisomerism: Optical activity and optical isomerism, asymmetry, chirality, enantiomers, diastereomers. specific rotation; Configuration and projection formulae: Newman, Sawhorse, Fischer and their interconversion. Chirality in molecules with one and two stereocentres; meso configuration.

Racemic mixture and their resolution. Relative and absolute configuration: D/L and R/S designations (CIP rules).

Geometrical isomerism: *cis-trans, syn-anti* and *E/Z* notations.

Conformational Isomerism: Alkanes (Conformations, relative stability and energy diagrams of Ethane, Propane and butane). Relative stability of cycloalkanes (Baeyer strain theory), Cyclohexane conformations with energy diagram. Conformations of monosubstituted cyclohexanes.

UNIT – III (18)
Unit III: Aliphatic Hydrocarbons

Alkanes: Preparation, Halogenation of alkanes, Concept of relative reactivity v/s selectivity.

Alkenes and Alkynes: Methods of preparation of alkenes using Mechanisms of E1, E2, E1cb reactions, Saytzeff and Hoffmann eliminations. Electrophilic additions, mechanism with suitable examples, (Markownikoff/Anti-markownikoff addition), *syn* and *anti*-addition; addition of H_2, X_2, oxymercuration-demercuration, hydroboration-oxidation, ozonolysis, hydroxylation, reaction with NBS, Reactions of alkynes; acidity, Alkylation of terminal alkynes, electrophilic addition: hydration to form carbonyl compounds, Relative reactivity of alkenes and alkynes, 1,2-and 1,4-addition reactions in conjugated dienes, Diels Alder reaction (excluding stereochemistry)

Practical component

Practical (30 Hours)
Credits: 01

(Laboratory periods: 15 classes of 2 hour each)

Note: *Students should be provided with handouts prior to the practical class*

1. Calibration of a thermometer and determination of the melting points of the organic compounds using any one of the following methods-Kjeldahl method, electrically heated melting point apparatus and BODMEL).

2. Concept of melting point and mixed melting point.

3. Concept of recrystallisation using alcohol/water/alcohol-water systems (Any two).
4. Determination of boiling point of liquid compounds (boiling point lower than and more than 100 °C by distillation, capillary method and BODMEL method)

5. Separation of a mixture of two amino acids/sugars by radial/ascending paper chromatography.

6. Separation of a mixture of *o*-and *p*-nitrophenol or *o*-and *p*-aminophenol by thin layer chromatography (TLC).

7. Detection of extra elements

Essential/recommended readings

References:

Theory

1. Morrison, R.N., Boyd, R.N., Bhattacharjee, S.K. (2010), **Organic Chemistry**, 7th Edition, Dorling Kindersley (India) Pvt. Ltd., Pearson Education.
2. Finar, I.L. (2002), **Organic Chemistry**, Volume 1, 6th Edition, Dorling Kindersley (India) Pvt. Ltd., Pearson Education.
3. Eliel, E.L., Wilen, S.H. (1994), **Stereochemistry of Organic Compounds**; Wiley: London.

Practicals

1. Mann, F.G., Saunders, B.C. (2009), **Practical Organic Chemistry**, 4th Edition, Pearson Education.
2. Ahluwalia, V.K., Dhingra, S. (2004), **Comprehensive Practical Organic Chemistry: Qualitative Analysis**, University Press.
3. Furniss, B.S., Hannaford, A.J., Smith, P.W.G.; Tatchell, A.R (2004), **Vogel's Textbook of Practical Organic Chemistry**, Pearson.
4. Leonard, J., Lygo, B., Procter, G. (2013) **Advanced Practical Organic Chemistry**, 3rd Edition, CRC Press.
5. Pasricha, S., Chaudhary, A. (2021), **Practical Organic Chemistry: Volume–I**, I K International Publishing house Pvt. Ltd, New Delhi

Suggestive readings

Additional Resources:

1. Solomons, T.W.G., Fryhle, C.B., Snyder, S.A. (2017), **Organic C hemistry**, 12th Edition, Wiley.
2. Bruice, P.Y. (2020), **Organic Chemistry**, 8th Edition, Pearson.
3. Clayden, J., Greeves, N., Warren, S. (2014), **Organic Chemistry**, Oxford.
4. Nasipuri, D. (2018), **Stereochemistry o f O rganic C ompounds: P rinciples a nd Applications**, 4th Edition, New Age International.
5. Gunstone, F.D. (1975), **Guidebook to Stereochemistry**, Prentice Hall Press.
6. Gupta, S.S. (2018), **Basic S tereochemistry o f O rganic Mo lecules,** 2nd Edition, Oxford University Press.

DISCIPLINE SPECIFIC CORE COURSE– 3 (DSC-3): Gaseous and Liquid

Credit distribution, Eligibility and Pre-requisites of the Course

Course t itle & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of t he co urse (if any)
		Lecture	Tutorial	Practical/ Practice		
Gaseous and Liquid State (DSC-3: Physical Chemistry-I)	**04**	**02**	**--**	**02**	Physics, Chemistry, Mathematics	**--**

Learning Objectives

The objective of this course is to develop basic and advance concepts regarding gases and liquids. It aims to study the similarity and differences between the two states of matter and reasons responsible for these. The objective of the practicals is to develop skills for working in physical chemistry laboratory. The student will perform experiments based on the concepts learnt in Physical chemistry-I course.

Learning outcomes

By the end of the course, the students will be able to:

- Derive mathematical expressions for different properties of gas and liquid and understand their physical significance.
- Apply the concepts of gas equations and liquids while studying other chemistry courses and every-day life.
- Handle stalagmometer and Ostwald viscometer properly.
- Determine the density of aqueous solutions.
- Dilute the given solutions as per required concentrations.
- Data reduction using numerical and graphical methods.

SYLLABUS OF DSC-3

UNIT – I (24 Hours)
Gaseous state

Kinetic theory of gases- postulates and derivation of kinetic gas equation, Maxwell distribution of molecular velocities and its use in evaluating average, root mean square and most probable velocities and average kinetic energy. Definition, expression, applications and temperature and pressure dependence of each one of the following properties of ideal gases: Collision frequency, Collision diameter, Mean free path. Coefficient of viscosity, definition, units and origin of viscosity of gases, relation between mean free path and coefficient of viscosity, temperature and pressure dependence of viscosity of a gas, calculation of molecular diameter from viscosity
Barometric distribution law, its derivation and applications, alternative forms of barometric distribution law in terms of density and number of molecules per unit volume, effect of height, temperature and molecular mass of the gas on barometric distribution

Behaviour of real gases- Compressibility factor, Z , Variation of compressibility factor with pressure at constant temperature *(plot of Z vs P)* for different gases (H_2, CO_2, CH_4 and NH_3), Cause of deviations from ideal gas behaviour and explanation of the observed behaviour of real gases in the light of molecular interactions

van der Waals (vdW) equation of state, Limitations of ideal gas equation of state and its modifications in the form of derivation of van der Waal equation, Physical significance of van der Waals constants, application of van der Waal equation to explain the observed behaviour of real gases.

Isotherms of real gases- Critical state, relation between critical constants and van der Waals constants, correlation of critical temperature of gases with intermolecular forces of attraction, Continuity of states, Limitations of van der Waals equation, Reduced equation of state and law of corresponding states (statement only).

Virial equation of state-Physical significance of second and third virial coefficients, van der Waals equation expressed in virial form, Relations between virial coefficients and van der Waals constants

UNIT – II (6 Hours)
Liquid state

Nature of liquid state, qualitative treatment of the structure of the liquid state

Physical properties of liquids-vapour pressure, its origin and definition, Vapour pressure of liquids and intermolecular forces, and boiling point

Surface tension, its origin and definition, Capillary action in relation to cohesive and adhesive forces, determination of surface tension by (i) using stalagmometer (drop number and drop mass method both) and (ii) capillary rise method, Effects of addition of sodium chloride, ethanol and detergent on the surface tension of water and its interpretation in terms of molecular interactions, Role of surface tension in the cleansing action of detergents

Coefficient of viscosity and its origin in liquids, Interpretation of viscosity data of pure liquids (water, ethanol, ether and glycerol) in the light of molecular interactions, Effects of addition of sodium chloride, ethanol and polymer on the viscosity of water, relative viscosity, specific viscosity and reduced viscosity of a solution, comparison of the origin of viscosity of liquids and gases, effect of temperature on the viscosity of a liquid and its comparison with that of a gas.

Practical component
Practicals **60 Hours**

(Laboratory periods: 15 classes of 4 hours each)

1. **Gases**
    a. To verify the Charles law using Charles law apparatus
    b. To determine the value of universal gas constant R using the reaction
    $Mg(s) + 2HCl (aq) \rightarrow MgCl_2 (aq) + H_2 (g)$

2. **Surface tension measurements using stalagmometer**
    a. Determine the surface tension of a liquid by drop number method.
    b. Determine the surface tension of a liquid by drop weight method.
    c. Study the variation of surface tension with different concentration of detergent solutions. Determine CMC.
    d. Study the effect of the addition of solutes on the surface tension of water at room temperature and explain the observations in terms of molecular interactions:
        (i) sugar
        (ii) ethanol
        (iii) sodium chloride
    e. Study the variation of surface tension with different concentration of sodium chloride solutions.

3. **Viscosity measurement using Ostwald's viscometer**
    a. Determination of co-efficient of viscosity of two unknown aqueous solution.
    b. Study the variation of viscosity with different concentration of sugar solutions.
    c. Study the effect of the addition of solutes such as (i) polymer (ii) ethanol (iii) sodium chloride on the viscosity of water at room temperature and explain the observations in terms of molecular interactions

d. Study the variation of viscosity of water with the amounts of a solute and calculate the intrinsic viscosity at room temperature.

e. Determine the viscosity average molecular mass of the polymer (PVA) using viscosity measurements.

Essential/recommended readings
References:

Theory:

1. Atkins, P.W.; Paula, J.de. (2014), **Atkin's Physical Chemistry Ed.**, 10th Edition, Oxford University Press.
2. Ball, D. W. (2017), **Physical Chemistry,** 2nd Edition, Cengage Learning, India.
3. Castellan, G. W. (2004), **Physical Chemistry**, 4th Edition, Narosa.
4. Kapoor, K.L. (2015), **A Textbook of Physical Chemistry**, Vol 1, 6th Edition, McGraw Hill Education.

Practical:

- Khosla, B.D.; Garg, V.C.; Gulati, A. (2015), **Senior Practical Physical Chemistry**, R. Chand & Co, New Delhi.
- Kapoor, K.L. (2019), **A Textbook of Physical Chemistry**, Vol.7, 1st Edition, McGraw Hill Education.
- Garland, C. W.; Nibler, J. W.; Shoemaker, D. P. (2003), **Experiments in Physical Chemistry**, 8th Edition, McGraw-Hill, New York.

Suggestive readings

Additional Resources:

1. Moore, W.J. (1972), **Physical Chemistry**, 5th Edition, Longmans Green & Co. Ltd. Glasstone, S. (1948), **Textbook of Physical Chemistry**, D. Van Nostrand company, New York.

BSc. IN ANALYTICAL CHEMISTRY
Multidisciplinary

DISCIPLINE S PECIFIC CORE COURSE (DS C1-AC1): Basic Principles and Laboratory Operations

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite o f the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Basic Principles and Laboratory Operations (DSC1-AC1)	**04**	**02**	**00**	**02**	Physics, Chemistry and Mathematics	**NIL**

Learning Objectives

The Learning Objectives of this course are as follows:

- make students aware about the SI Units, concentration terms, various analytical methods, and safe usage of chemicals and its waste.

Learning outcomes

The Learning Outcomes of this course are as follows:

- The students will be able to Understand SI units
- The students will be able to Learn the use of analytical equipment
- The students will be able to Know the types of errors in chemical analysis
- The students will be able to handle statistical tests of data

SYLLABUS OF DSC1-AC1

UNIT – I: Basic Concepts (6 Hours)

A. SI Units
· Definitions of the Seven Base Units
· Derived units
· Conversion between units
· Significant figures

B. Chemical concentrations
· Mole, molar mass (calculations in grams and moles)
· Solutions and their concentrations

· Molar concentration
· Analytical molarity
· Equilibrium molarity of a particular species
· Percent concentration
· Parts per million/billion (ppm, ppb)
· Volume ratios for dilution procedures
· p-functions.

UNIT – II: Introduction to Analytical Chemistry and Analytical Methods (4 Hours)

1. General steps in chemical analysis.
2. Introduction to methods of detecting analytes
   a) Physical
   b) Electromagnetic radiations
   c) Electric charge.

UNIT – III: Errors in Chemical Analysis (20 Hours)

- Types of errors
- Accuracy and Precision, Absolute and relative uncertainty, propagation of uncertainty
- The Gaussian distribution
- Mean and standard deviation
- Confidence intervals
- Statistical tests of data (F test, t test, Q test for bad data)
- Method of least squares
- Calibration curve
- Safety with chemicals and waste

Practical component 60 Hours (Credits: 02; Laboratory Periods: 60; 15 Classes of 4 hours each)

1. Description, Use and Calibration of Common Laboratory Apparatus I: Glassware: Volumetric flasks, Burettes, Pipettes, Weighing bottles, Drying ovens.
2. Description, Use and Calibration of Common Laboratory Apparatus II: Different types of Funnels, Chromatographic columns, Chromatographic jars, Desiccators, Filter crucibles, Rubber policeman.
3. Preparing Solutions: Standard solutions (acids and bases), primary standards & secondary standards, and to find out their concentration by any suitable methods.
4. Determination of strength of given strong acid using strong base volumetrically
5. Estimation of sodium carbonate by titrating with hydrochloric acid.
6. Use and maintenance of pH meter. Determination of pH of given dilute solutions of shampoos, soaps, fruit juices, and different soft drinks.
7. Determination of cell constant of a conductometric cell using standard KCl solutions.
8. To check the conductivity of various water samples (*Collect at least four samples*).

Essential/recommended readings

- Higson, S. P.J. (2003), Analytical Chemistry, Oxford University Press.

- Skoog, D.A.; West, D.M. (2003), Fundamentals of Analytical Chemistry, Brooks/Cole.
- Christian, G.D. (2004), Analytical Chemistry, 6th Edition, John Wiley & Sons, New York.
- Fifield, F.W.; Kealey, D. (2000), Principles and Practice of Analytical Chemistry, Wiley.
- Harris, D. C. (2007), Exploring Chemical Analysis, W.H. Freeman and Co.

Suggestive readings

- Day. R. A.; Underwood, A. L. (1991), Quantitative Analysis, Prentice Hall of India.
- Gordus, A. A. (1985), Schaum's Outline of Analytical Chemistry, Tala McGraw-Hill.
- Dean J. A. (1997), Analytical Chemistry Handbook, McGraw Hill.
- Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C. (1989), Vogel's Textbook of Quantitative Chemical Analysis, John Wiley and Sons.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 2 (DSC2-C1): Fundamentals of Organic Chemistry, Stereochemistry and Hydrocarbons

Credit distribution, Eligibility and Prerequisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Fundamentals of Organic Chemistry, Stereochemistry and Hydrocarbons (DSC2-C1)	04	02	00	02	Physics, Chemistry and Mathematics	-

Learning Objectives

The Learning Objectives of this course are as follows:

- The course is infused with the recapitulation of fundamentals of organic chemistry and visualizing the organic molecules in a three-dimensional space.
- To establish the applications of these concepts different class of mechanism is included.
- The constitution of the course strongly aids in the paramount learning of the concepts and their applications.

Learning outcomes

By the end of the course, the students will be able to:

- Understand and explain the differential behaviour of organic compounds based on fundamental concepts learnt.
- Understand the stereochemistry of aliphatic and aromatic hydrocarbons
- Formulate the mechanism of organic reactions by recalling and correlating the fundamental properties of the reactants involved.
- Learn and identify many organic reaction mechanisms including electrophilic addition, nucleophilic addition, nucleophilic substitution, and electrophilic substitution.
- Understand the mechanism of reactions of hydrocarbons

SYLLABUS OF DSC2-C1

UNIT – I: Fundamentals of Organic Chemistry (4 Hours)

Introduction to carbon compounds, an overview of Fundamentals (Electronic displacement- Inductive effect, Resonance effect, Hyperconjugation, Electromeric Effect). Reactive intermediates and their stability: carbocations, free radicals, carbanions, benzyne, carbene.

Acidity and basicity in carbon compounds (comparison of carboxylic acids, alcohols, phenols, primary, secondary and tertiary aliphatic amines, aniline and its derivative.

UNIT – II: Stereochemistry (8 Hours)

Types of projection formulas of carbon compound - Flying Wedge Formula, Newmann, Sawhorse and Fischer representations and their interconversion.

Stereoisomerism: the concept of chirality (upto two carbon atoms). Configurational Isomerism: geometrical and optical isomerism; enantiomerism, diastereomerism and meso compounds). Threo and erythro; D and L; cis-trans nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z nomenclature (for upto two C=C systems).

Conformational isomerism with respect to ethane, butane and cyclohexane.

UNIT – III: Aliphatic Hydrocarbons (12 Hours)

Functional group approach for the following reactions: preparations, physical property & chemical reactions to be studied with the mechanism in context to their structure.

Alkanes: Preparation: catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, Grignard reagent. Reactions: Free radical substitution: Halogenation.

Alkenes: Preparation: Elimination reactions: Dehydration of alcohols and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). Reactions: cis-addition (alk. KMnO4) and trans-addition (bromine), the addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymecuration-demercuration, Hydroboration oxidation.

Alkynes: Preparation: Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetrahalides and dehydrohalogenation of vicinal-dihalides. Reactions: formation of metal acetylides and acidity of alkynes, the addition of bromine and alkaline

$KMnO_4$, ozonolysis and oxidation with hot alk. $KMnO_4$. Hydration to form carbonyl compounds.

UNIT – IV: Aromatic Hydrocarbons (6 Hours)

Aromaticity: benzenoids and Hückel's rule. Structure and aromatic character of benzene.
Preparation: methods of preparation of benzene from phenol, benzoic acid, acetylene and benzene sulphonic acid. Reactions: electrophilic substitution reactions in benzene citing examples of nitration, halogenation, sulphonation and Friedel-Craft's alkylation and acylation with emphasis on carbocationic rearrangement, side-chain oxidation of alkylbenzenes.

Practical component (60 Hours) (Credits: 02; Laboratory Periods: 60; 15 Classes of 4 hours each)

1. Purification of organic compounds by crystallization using the following solvents:
   a. Water
   b. Alcohol
   c. Water + alcohol
2. Determination of the melting points of organic compounds using Kjeldahl method and electrically heated melting point apparatus.
3. To study the effect of impurities on the melting point.
4. To identify the organic compounds using mixed melting point experiment. (*Identify at least two organic compounds*).
5. Determination of boiling point of liquid organic compounds using both distillation and capillary method.
6. Detection of extra elements present in an organic compounds (*Upto two extra elements*).
7. Organic Preparations:
   a. Bromination of acetanilide, phenol and aniline
   b. Nitration of nitrobenzene and bromobenzene

Essential/recommended readings

- Sykes, P.(2005), A Guide Book to Mechanism in Organic Chemistry, Orient Longman.
- Eliel, E. L. (2000), Stereochemistry of Carbon Compounds, Tata McGraw Hill.
- Morrison, R. N.; Boyd, R. N. (2010) Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), 7th Edition.
- Bahl, A; Bahl, B. S. (2012), Advanced Organic Chemistry, S. Chand.
- Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. (2012), Vogel's Textbook of Practical Organic Chemistry, Pearson.
- Mann, F.G.; Saunders, B.C.(2009), Practical Organic Chemistry, Pearson Education.
- Dhingra, S; Ahluwalia V.K., (2017), Advanced Experimental Organic Chemistry, Manakin Press.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

BSc. In Industrial Chemistry
Multidisciplinary

DISCIPLINE SPECIFIC CORE COURSE (DSC-IC 1): INDUSTRIAL CHEMICALS AND ENVIRONMENT

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Industrial Chemicals and Environment, DSC- IC 1	**04**	**02**	**-**	**02**	Chemistry+Physics +Maths	**NA**

Industrial Chemicals and Environment, DSC- IC 1

Learning Objectives

The Learning Objectives of this course are as follows:

- The objective of this course is to teach the Chemistry of the general industrial separation and purification techniques.
- Production, uses and hazards associated with different industrial gases and chemicals.
- Air pollution, air pollutants, pollutants control procedures, greenhouse effect, global warming,
- Water pollution, water pollutants, industrial effluents and their treatment.
- Water quality parameters and water purification techniques.

Learning outcomes

The Learning Outcomes of this course are as follows:

By the end of the course, the students will be able to:

- Know the various separation and purification techniques used in industries like distillation, solvent extraction, absorption, adsorption etc.
- Know the production, uses and hazards of important gases like oxygen, helium, argon, hydrogen, acetylene, ammonia etc.

- Know the production, uses and hazards of important inorganic chemicals like hydrochloric acid, sulphuric acid, nitric acid, sodium hydroxide, potassium hydroxide etc.
- Learn about air pollution, air pollutants, their control procedure, global warming, ozone depletion, water pollution, water pollutants, effluents from different industries, their treatment, water quality parameters and water purification techniques like reverse osmosis, electrodialysis and ion exchange.

SYLLABUS OF DSC- IC-1

UNIT – I (06 Hours)
Unit 1: General industrial processes

Basic principles of distillation, solvent extraction, solid-liquid leaching and liquid-liquid extraction, separation by absorption and adsorption

UNIT – II (12 Hours)
Unit 2: Industrial Gases and Inorganic Chemicals

(a) *Industrial Gases*: Production, uses and hazards in handling of the following gases: oxygen,
nitrogen, argon, neon, helium, hydrogen, acetylene, chlorine, fluorine and ammonia.
(b) *Inorganic Chemicals*: Production, uses and hazards in handling the following chemicals: hydrochloric acid, nitric acid, sulphuric acid, sodium hydroxide, potassium hydroxide, bleaching
powder, hydrogen peroxide, potash alum, chrome alum, potassium dichromate and potassium permanganate.

UNIT – III (12 Hours)
Unit 3: Environment

(a) *Air Pollution*: Pollutants and their sources, pollution by SO2, CO, NOx. Methods of estimation of CO, NOx, SOx and their control procedures. Greenhouse effect and global warming, Ozone depletion by oxides of nitrogen, chlorofluorocarbons and halogens, Particulate matter and its types.
(b) *Water Quality Standards and Water pollution:* Water quality parameters like pH, alkalinity, DO, BOD, COD, chloride, sulphate, available chlorine etc. Water treatment and purification processes (reverse osmosis, electro dialysis, ion exchange). Pollutants and their sources. Effluent treatment (primary, secondary and tertiary treatment). Industrial effluents from the following industries and their treatment: textile, tannery, dairy and petrochemicals and agrochemicals.

Practical component (60 Hours)
Practical
(Credits: 02, Laboratory periods: 60)
1. Determination of dissolved oxygen in water.
2. Determination of Chemical Oxygen Demand (COD).
3. Determination of Biological Oxygen Demand (BOD).

4. Measurement of chloride and sulphate ions of water samples by simple titration method. (With $AgNO_3$ and potassium chromate).
5. Measurement of salinity of water samples by simple titration method. (With $AgNO_3$ and potassium chromate).
6. Estimation of total alkalinity of water samples (CO_3^{2-} , HCO_3^-) using double titration method.
7. Determination of Percentage of available chlorine in bleaching powder.
8. Isolation of compounds using solvent extraction method.

Essential/recommended readings

References (Theory):

1. Stocchi, E. (1990), **Industrial Chemistry**, Vol-I, Ellis Horwood Ltd. UK.
2. Kent, J. A. (ed.) (1997), **Riegel's Handbook of Industrial Chemistry**, CBS Publishers, New Delhi.
3. Austin, G.T (2012), **Shreve's Chemical Process Industries**, Tata McGraw-Hill Education Private Limited.
4. Girard, J.E, (2011), **Principles of Environmental Chemistry**, Jones & Bartlett India Pvt. Limited.
5. Sodhi, G.S. ((2013), **Fundamental Concepts of Environmental Chemistry**, Narosa Publishing House.
6. Vermani, O.P; Narula, A.K. (2012), **Industrial Chemistry**, Galgotia Publishing Pvt. Limited.
7. Sharma, B.K. (2011), **Industrial Chemistry**, Goel Publishing House.
8. Pani, B. (2017), **Textbook of Environmental Chemistry**, I.K. International Publishing House.
9. De, A. K. (2015), **Environmental Chemistry**, New Age International Pvt, Ltd, New Delhi.10. Khopkar, S.M. (2012), **Environmental Pollution Analysis**, New Age International Publisher.

References (Practical):

1. Bassett,J.; Denney, R.C.; Jeffery, G.H.; Mendham, J.(1996) **Vogel Textbook of quantitative inorganic analysis**, 7th edition, ELBS edition.Prentice Hall Publications.
2. Furniss, B. S; Hannaford, A. J.; Smith, Peter W. G.; Tatchell, A. R; **Vogel's Text Book of Practical Organic Chemistry**, 5th Edition, Longman Scientific and Technical, Longman Group Ltd.
3. Mittal, K.; Chandra, L.(2013) **Experiments in organic chemistry**, Anne Books Pvt. Limited.
4. Gulati, S.; Sharma, J.L.; Manocha, S. (2017) **Practical Inorganic Chemistry**. CBS, Publications.
5. Rogers, A. (2015) **Laboratory Guide of Industrial chemistry**, Palala Press.

Suggestive readings (if any)

DISCIPLINE SPECIFIC CORE COURSE – 2 (DSC-C 1):
Basic Concepts of Organic Chemistry

Credit distribution, Eligibility and Prerequisites of the Course

Course t itle & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Basic Concepts of Organic Chemistry, DSC- C1	**04**	**02**	**-**	**02**	**NA**	**NA**

Basic Concepts of Organic Chemistry, DSC- C1

Learning Objectives

The Learning Objectives of this course are as follows:

- The course is infused with the recapitulation of fundamentals of organic chemistry and the introduction of the concept of visualizing the organic molecules in a three-dimensional space. To establish the applications of these concepts, a study of diverse reactions through mechanisms is included.
- The constitution of the course strongly aids in the paramount learning of the basic concepts and their applications.

Learning outcomes

By the end of the course, the students will be able to:

- Understand and explain the differential behaviour of organic compounds based on fundamental concepts learnt.
- Understand the fundamental concepts of stereochemistry.
- Formulate the mechanism of organic reactions by recalling and correlating the fundamental properties of the reactants involved.
- Learn and identify many organic reactions and their mechanisms including electrophilic addition, nucleophilic addition, nucleophilic substitution, electrophilic substitution and rearrangement reactions.

SYLLABUS OF DSC- C 1

UNIT – I (6 Hours)
Unit 1: Fundamentals of organic chemistry

Types of Electronic displacements: Inductive effect, Resonance effect, Hyperconjugation, Electromeric Effect. Reactive intermediates and their stability: carbocations, free radicals, carbanions, benzyne, carbenes.

Acidity and basicity in organic compounds (comparison of carboxylic acids, alcohols, phenols, primary, secondary and tertiary aliphatic amines, aniline and its derivatives)

UNIT – II (8 Hours)
Unit 2: Stereochemistry

Types of projection formulae: Flying Wedge Formula, Newmann, Sawhorse and Fischer representations and their interconversion.
Stereoisomerism: Concept of chirality (upto two carbon atoms). Configurational isomerism: geometrical and optical isomerism; enantiomerism, diastereomerism and meso compounds). Threo and erythro; D and L; *Cis-trans* nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and *E*/*Z* nomenclature (for upto two C=C systems).
Conformational isomerism with respect to ethane, butane and cyclohexane.

UNIT – III (16 Hours)
Unit 3: Types of Organic Reactions (Including reactions of alkenes, alkyl and aryl halides, alcohols, aldehydes, ketones) Lectures: 18
Electrophilic addition reactions
Electrophilic addition reaction (with respect to propene, propyne, 3,3-dimethyl-1-butene): Hydration,
Addition of HX in the absence and presence of peroxide, Hydroboration oxidation, Addition of
bromine (with stereochemistry).
Nucleophilic addition reactions
Nucleophilic addition reaction of carbonyl compounds: Addition of HCN, ammonia derivatives
(Hydroxylamine, Hydrazine, Semicarbazide and 2,4-DNP), the addition of carbanion (Aldol
condensation, Claisen Schmidt, Benzoin condensation, Perkin reaction, reactions involving Grignard
reagent).
Elimination and Nucleophilic substitution reactions
Nucleophilic substitution reaction (SN1 and SN2) in alkyl halides (mechanisms with stereochemical aspect), alcohols (with nucleophiles like ammonia, halides, thiols, ambident nucleophiles (cyanide and nitrite ion)), ethers (Williamson ether synthesis), Elimination reaction (E1 & E2), elimination *vs* substitution (*w.r.t*. potassium t-butoxide and KOH); Nucleophilic aromatic substitution in aryl
halides-elimination addition reaction *w.r.t.* chlorobenzene, including the effect of nitro group (on the ring) on the reaction. relative reactivity and strength of C-X bond in alkyl, allyl, benzyl, vinyl and aryl halides towards substitution reactions
Electrophilic substitution reactions
Electrophilic Aromatic substitution with mechanism (benzene)- sulphonation, nitration, halogenation, Friedel craft acylation :*o*-, *m*- and *p*- directive influence giving examples of toluene/nitrobenzene/ phenol/ aniline/ chlorobenzene.
Reactive intermediates and Rearrangement Reactions
Free radicals (Birch Reduction); *Carbocations* (Pinacol-Pinacolone, Wagner-Meerwein,
Rearrangement, and Beckmann rearrangement); *Carbanions (*Michael Addition); *Carbenes* (Reimer Tiemann)

Practical component (60 Hours)

Practical

(Credits: 02, Laboratory periods: 60)

1. Purification of an organic compound by crystallization (from water and alcohol) and distillation, Criteria of purity: Determination of M.P.
2. Determination of boiling point of liquid compounds. (Boiling point lower than and more than 100 °C by distillation and capillary method)
3. Detection of extra element
4. Preparations: (Mechanism of various reactions involved to be discussed).
    a. Bromination of phenol/aniline.
    b. 2,4-Dinitrophenylhydrazone of aldehydes and ketones
    c. Semicarbazone of aldehydes/ ketones
    d. Aldol condensation reaction using green method.
    e. Bromination of Stilbene.
    f. Acetanilide to p-Bromoacetanilide.

The above derivatives should be prepared using 0.5-1g of the organic compound. The solid samples must be collected and may be used for recrystallization and melting point.

Essential/recommended readings

References (Theory):

1. Sykes, P.(2003), **A Guide Book to Mechanism in Organic Chemistry,** 6 th Edition Pearson Education.
2. Eliel, E. L. (2001), **Stereochemistry of Carbon Compounds**, Tata McGraw Hill.
3. Morrison, R. N.; Boyd, R. N., Bhattacharjee, S.K. (2010), **Organic Chemistry**, 7th Edition, Pearson Education.
4. Bahl, A; Bahl, B. S. (2019), **Advanced Organic Chemistry**, 22nd Edition, S. Chand.

References (Practical):

1. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. (2012), **Vogel's Textbook of Practical Organic Chemistry**, Pearson.
2. Mann, F.G.; Saunders, B.C. (2009), **Practical Organic Chemistry**, Pearson Education.
3. Dhingra, S; Ahluwalia V.K., (2017), **Advanced Experimental Organic Chemistry**, Manakin Press.
4. Pasricha, S., Chaudhary, A. (2021), **Practical Organic Chemistry: Volume I**, I K International Publishing House Pvt. Ltd., New Delhi.

DISCIPLINE SPECIFIC CORE COURSE – 3 (DSC-MP 1): Calculus

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Calculus, DSC-MP 1	**04**	**02**	**-**	**02**	**NA**	**NA**

Course Code: Mathematics DSC-MP 1
Course Title: Calculus

Learning Objectives

The Learning Objectives of this course are as follows:

Course Objectives: The primary objective of this course is to introduce the basic tools of calculus which are helpful in understanding their applications in many real-world problems. Students will be able to understand/create various mathematical models in everyday life.

Learning outcomes

The Learning Outcomes of this course are as follows:

This course will enable the students to:
i) Understand continuity and differentiability in terms of limits and graphs of certain functions.
ii) Describe asymptotic behaviour in terms of limits involving infinity.
iii) Use of derivatives to explore the behaviour of a given function locating and classify its extrema and graphing the function.
iv) Apply the concepts of asymptotes, and inflexion points in tracing of cartesian curves.
v) Compute the reduction formulae of standard transcendental functions with applications.

SYLLABUS OF DSC- MP 1

UNIT – I (10 Hours)
Unit 1: Limits, Continuity and Differentiability
Limit of a function, $\varepsilon-\delta$ definition of a limit, Infinite limits, Continuity and types of discontinuities; Differentiability of a function, Successive differentiation: Calculation of the nth derivatives, Leibnitz theorem; Partial differentiation, Euler's theorem on homogeneous functions.

UNIT – II (10 Hours)
Unit 2: Mean Value Theorems and its Applications
Rolle's theorem, Mean value theorems and applications to monotonic functions and inequalities; Taylor's theorem, Taylor's series, Maclaurin's series expansions of e^x , sin x, cos x, $\log(1+x)$ and $(1+x)^m$; Indeterminate forms.

UNIT – III (10 Hours)
Unit 3: Tracing of Curves and Reduction Formulae
Asymptotes (parallel to axes and oblique), Concavity and inflexion points, Singular points, Tangents at the origin and nature of singular points, Curve tracing (cartesian and polar equations). Reduction formulae for $\int \sin^n x\, dx$, $\int \cos^n x\, dx$, and $\int \sin^m x \cos^n x\, dx$ and their applications.

Essential/recommended readings

References:

1. Prasad, Gorakh (2016). *Differential Calculus* (19th ed.). Pothishala Pvt. Ltd. Allahabad.
2. Prasad, Gorakh (2015). *Integral Calculus*. Pothishala Pvt. Ltd. Allahabad.

Additional Readings:

i. Apostol, T. M. (2007). *Calculus*: *One-Variable Calculus with An Introduction to Linear Algebra* (2nded.). Vol. 1. Wiley India Pvt. Ltd.
ii. Ross, Kenneth. A.(2013). *Elementary Analysis*: *The Theory of Calculus* (2nd ed.). Undergraduate Texts in Mathematics, Springer. Indian reprint.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

BSc. Life Sciences
Multidisciplinary

DISCIPLINE SPECIFIC CORE COURSE (DSC-1): Basic Concepts of Organic

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course t itle & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Basic Concepts of Organic Chemistry	04	02	-	02	**12^{th} Pass**	**NIL**

Learning Objectives

The Learning Objectives of this course are as follows:

- The course is infused with the recapitulation of fundamentals of organic chemistry and the introduction of the concept of visualizing the organic molecules in a three-dimensional space.
- To establish the applications of these concepts, a study of diverse reactions through mechanisms is included.
- The constitution of the course strongly aids in the paramount learning of the basic concepts and their applications

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand and explain the differential behavior of organic compounds based on fundamental concepts learned.
- Understand the fundamental concepts of stereochemistry.
- Formulate the mechanism of organic reactions by recalling and correlating the fundamental properties of the reactants involved.
- Learn and identify many organic reactions and their mechanisms including electrophilic addition, nucleophilic addition, nucleophilic substitution, electrophilic substitution and rearrangement reactions.

SYLLABUS OF DSC-1

UNIT – I Fundamentals of organic chemistry (6 Hours)
Types of Electronic displacements: Inductive effect, Resonance effect, Hyperconjugation, Electromeric Effect. Reactive intermediates and their stability: carbocations, free radicals, carbanions, benzyne, carbenes. Acidity and basicity in organic compounds (comparison of

carboxylic acids, alcohols, phenols, primary, secondary and tertiary aliphatic amines, aniline and its derivatives)

UNIT – II Stereochemistry (6 Hours)

Types of projection formulae: Flying Wedge Formula, Newmann, Sawhorse and Fischer representations and their interconversion.

Stereoisomerism: Concept of chirality (upto two carbon atoms). Configurational isomerism: geometrical and optical isomerism; enantiomerism, diastereomerism and meso compounds). Threo and erythro; D and L; *Cis-trans* nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and *E*/*Z* nomenclature (for upto two C=C systems).

Conformational isomerism with respect to ethane, butane and cyclohexane.

UNIT – III Types of Organic Reactions (Including reactions of alkenes, alkyl and aryl halides, alcohols, aldehydes, ketones) (18 Hours)

Electrophilic addition reactions

Electrophilic addition reaction (with respect to propene, propyne, 3,3-dimethyl-1-butene): Hydration, Addition of HX in the absence and presence of peroxide, Hydroboration oxidation, Addition of bromine (with stereochemistry).

Nucleophilic addition reactions

Nucleophilic addition reaction of carbonyl compounds: Addition of HCN, ammonia derivatives (Hydroxylamine, Hydrazine, Semicarbazide and 2,4-DNP), the addition of carbanion (Aldol condensation, Claisen Schmidt, Benzoin condensation, Perkin reaction, reactions involving Grignard reagent).

Elimination and Nucleophilic substitution reactions

Nucleophilic substitution reaction (S_N1 and S_N2) in alkyl halides (mechanisms with stereochemical aspect), alcohols (with nucleophiles like ammonia, halides, thiols, ambident nucleophiles (cyanide and nitrite ion)), ethers (Williamson ether synthesis), Elimination reaction (E1 & E2), elimination *vs* substitution (*w.r.t.* potassium t-butoxide and KOH); Nucleophilic aromatic substitution in aryl halides-elimination addition reaction *w.r.t.* chlorobenzene, including the effect of nitro group (on the ring) on the reaction. relative reactivity and strength of C-X bond in alkyl, allyl, benzyl, vinyl and aryl halides towards substitution reactions

Electrophilic substitution reactions

Electrophilic Aromatic substitution with mechanism (benzene)- sulphonation, nitration, halogenation, Friedel craft acylation :*o*-, *m*- and *p*- directive influence giving examples of toluene/nitrobenzene/ phenol/ aniline/ chlorobenzene.

Reactive intermediates and Rearrangement Reactions

Free radicals (Birch Reduction); *Carbocations* (Pinacol-Pinacolone, Wagner-Meerwein, Rearrangement, and Beckmann rearrangement); *Carbanions (*Michael Addition); *Carbenes* (Reimer-Tiemann).

Practical component (60 Hours)

1. Purification of an organic compound by crystallization (from water and alcohol) and distillation, Criteria of purity: Determination of M.P.
2. Determination of boiling point of liquid compounds. (Boiling point lower than and more than 100 °C by distillation and capillary method)
3. Detection of extra element
4. Preparations: (Mechanism of various reactions involved to be discussed).

   a. Bromination of phenol/aniline.
   b. 2,4-Dinitrophenylhydrazone of aldehydes and ketones
   c. Semicarbazone of aldehydes/ ketones
   d. Aldol condensation reaction using green method.
   e. Bromination of Stilbene.
   f. Acetanilide to p-Bromoacetanilide.

The above derivatives should be prepared using 0.5-1g of the organic compound. The solid samples must be collected and may be used for recrystallization and melting point.

Essential/recommended readings
Theory:

1. Sykes, P.(2003), **A Guide Book to Mechanism in Organic Chemistry,** 6th Edition Pearson Education.
2. Eliel, E. L. (2001), **Stereochemistry of Carbon Compounds**, Tata McGraw Hill.
3. Morrison, R. N.; Boyd, R. N., Bhattacharjee, S.K. (2010), **Organic Chemistry**, 7th Edition, Pearson Education.

Practical:

1. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. (2012), **Vogel's Textbook of Practical Organic Chemistry**, Pearson.
2. Mann, F.G.; Saunders, B.C. (2009), **Practical Organic Chemistry**, Pearson Education.
3. Dhingra, S; Ahluwalia V.K., (2017), **Advanced Experimental Organic Chemistry**, Manakin Press.

Suggestive readings

Theory:

1. Bahl, A; Bahl, B. S. (2019), **Advanced Organic Chemistry**, 22nd Edition, S. Chand.

Practical:

1. Pasricha, S., Chaudhary, A. (2021), **Practical Organic Chemistry: Volume I**, I K International Publishing House Pvt. Ltd., New Delhi.

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BSc. Physical Sciences

DISCIPLINE SPECIFIC CORE COURSE (DSC-1): Basic Concepts of Organic Chemistry

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course t itle & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Basic Concepts of Organic Chemistry	04	02	-	02	**12th Pass**	**NIL**

Learning Objectives

The Learning Objectives of this course are as follows:

- The course is infused with the recapitulation of fundamentals of organic chemistry and the introduction of the concept of visualizing the organic molecules in a three-dimensional space.
- To establish the applications of these concepts, a study of diverse reactions through mechanisms is included.
- The constitution of the course strongly aids in the paramount learning of the basic concepts and their applications

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand and explain the differential behavior of organic compounds based on fundamental concepts learned.
- Understand the fundamental concepts of stereochemistry.
- Formulate the mechanism of organic reactions by recalling and correlating the fundamental properties of the reactants involved.
- Learn and identify many organic reactions and their mechanisms including electrophilic addition, nucleophilic addition, nucleophilic substitution, electrophilic substitution and rearrangement reactions.

SYLLABUS OF DSC-1

UNIT – I Fundamentals of organic chemistry (6 Hours)

Types of Electronic displacements: Inductive effect, Resonance effect, Hyperconjugation, Electromeric Effect. Reactive intermediates and their stability: carbocations, free radicals, carbanions, benzyne, carbenes.

Acidity and basicity in organic compounds (comparison of carboxylic acids, alcohols, phenols, primary, secondary and tertiary aliphatic amines, aniline and its derivatives)

UNIT – II Stereochemistry (6 Hours)
Types of projection formulae: Flying Wedge Formula, Newmann, Sawhorse and Fischer representations and their interconversion.
Stereoisomerism: Concept of chirality (upto two carbon atoms). Configurational isomerism: geometrical and optical isomerism; enantiomerism, diastereomerism and meso compounds). Threo and erythro; D and L; *Cis-trans* nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and *E*/*Z* nomenclature (for upto two C=C systems).
Conformational isomerism with respect to ethane, butane and cyclohexane.

UNIT – III Types of Organic Reactions (Including reactions of alkenes, alkyl and aryl halides, alcohols, aldehydes, ketones) (18 Hours)
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Electrophilic addition reaction (with respect to propene, propyne, 3,3-dimethyl-1-butene): Hydration, Addition of HX in the absence and presence of peroxide, Hydroboration oxidation, Addition of bromine (with stereochemistry).

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Nucleophilic addition reaction of carbonyl compounds: Addition of HCN, ammonia derivatives (Hydroxylamine, Hydrazine, Semicarbazide and 2,4-DNP), the addition of carbanion (Aldol condensation, Claisen Schmidt, Benzoin condensation, Perkin reaction, reactions involving Grignard reagent).

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Electrophilic Aromatic substitution with mechanism (benzene)- sulphonation, nitration, halogenation, Friedel craft acylation :*o*-, *m*- and *p*- directive influence giving examples of toluene/nitrobenzene/ phenol/ aniline/ chlorobenzene.

Reactive intermediates and Rearrangement Reactions
Free radicals (Birch Reduction); *Carbocations* (Pinacol-Pinacolone, Wagner-Meerwein, Rearrangement, and Beckmann rearrangement); *Carbanions (*Michael Addition); *Carbenes* (Reimer-Tiemann).

Practical component (60 Hours)

1. Purification of an organic compound by crystallization (from water and alcohol) and distillation, Criteria of purity: Determination of M.P.
2. Determination of boiling point of liquid compounds. (Boiling point lower than and more than 100 °C by distillation and capillary method)
3. Detection of extra element
4. Preparations: (Mechanism of various reactions involved to be discussed).
   a. Bromination of phenol/aniline.
   b. 2,4-Dinitrophenylhydrazone of aldehydes and ketones
   c. Semicarbazone of aldehydes/ ketones
   d. Aldol condensation reaction using green method.
   e. Bromination of Stilbene.
   f. Acetanilide to p-Bromoacetanilide.

The above derivatives should be prepared using 0.5-1g of the organic compound. The solid samples must be collected and may be used for recrystallization and melting point.

Essential/recommended readings
Theory:

1. Sykes, P.(2003), **A Guide Book to Mechanism in Organic Chemistry,** 6th Edition Pearson Education.
2. Eliel, E. L. (2001), **Stereochemistry of Carbon Compounds**, Tata McGraw Hill.
3. Morrison, R. N.; Boyd, R. N., Bhattacharjee, S.K. (2010), **Organic Chemistry**, 7th Edition, Pearson Education.

Practical:

1. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. (2012), **Vogel's Textbook of Practical Organic Chemistry**, Pearson.
2. Mann, F.G.; Saunders, B.C. (2009), **Practical Organic Chemistry**, Pearson Education.
3. Dhingra, S; Ahluwalia V.K., (2017), **Advanced Experimental Organic Chemistry**, Manakin Press.

Suggestive readings
Theory:

1. Bahl, A; Bahl, B. S. (2019), **Advanced Organic Chemistry**, 22nd Edition, S. Chand.

Practical:

1. Pasricha, S., Chaudhary, A. (2021), **Practical Organic Chemistry: Volume I**, I K International Publishing House Pvt. Ltd., New Delhi.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

COMMON POOL OF GENERIC ELECTIVES (GE) COURSES

OFFERED BY DEPARTMENT OF CHEMISTRY FOR ODD SEMESTER

GE 1: Chemistry: Atomic Structure and Chemical Bonding

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course titl e & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Atomic Structure and Chemical Bonding (GE-1)	4	2		2		Basic knowledge of Chemistry

Learning Objectives

The Learning Objectives of this course are as follows:

- To discuss the structure of atom as a necessary pre-requisite in understanding the nature of chemical bonding in compounds.
- To provide basic knowledge about ionic and covalent bonding.

Learning Outcomes

By the end of the course, the students will be able to:

- Solve the conceptual questions using the knowledge gained by studying the quantum mechanical model of the atom, quantum numbers, electronic configuration, radial and angular distribution curves, and shapes of s, p, and d orbitals
- Understand the concept of lattice energy and solvation energy.
- Draw the plausible structures and geometries of molecules using radius ratio rules, VSEPR theory and MO diagrams (homo- & hetero-nuclear diatomic molecules).

SYLLABUS OF GE 1

Theory:

Unit – 1: Atomic Structure **(14 Hours)**

Review of: Bohr's theory and its limitations, Heisenberg uncertainty principle, Dual behaviour of matter and radiation, De-Broglie's relation, Hydrogen atom spectra, need of a new approach to atomic structure. Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and ψ^2, Schrödinger equation for hydrogen atom, radial and angular parts of the hydrogen wave functions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation), radial and angular nodes and their significance, radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals. Significance of quantum numbers, orbital angular momentum and quantum numbers ml and m_s. Shapes of s, p and d atomic orbitals, nodal planes, discovery of spin, spin quantum number (s) and magnetic spin quantum number (m_s). Rules for filling electrons in various orbitals, electronic configurations of the atoms, stability of half-filled and completely filled orbitals, concept of exchange energy, relative energies of atomic orbitals, anomalous electronic configurations.

Unit – 2: Chemical Bonding and Molecular Structure (16 Hours)

Ionic Bonding: General characteristics of ionic bonding, energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds, statement of Born-Landé equation for calculation of lattice energy (no derivation), Born Haber cycle and its applications, covalent character in ionic compounds, polarizing power and polarizability, Fajan's rules. Ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character. Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR (H_2O, NH_3, PCl_5, SF_6, ClF_3, SF_4) and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements. Concept of resonance and resonating structures in various inorganic and organic compounds. MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for ss, s-p and p-p combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1^{st} and 2^{nd} periods (including idea of s-p mixing) and heteronuclear diatomic molecules such as CO, NO and NO^+.

Practicals: (60 Hours)

(Laboratory Periods: 60)

1. Acid-Base Titrations: Principles of acid-base titrations to be discussed.

(i) Estimation of sodium carbonate using standardized HCl.
(ii) Estimation of carbonate and hydroxide present together in a mixture.
(iii) Estimation of carbonate and bicarbonate present together in a mixture.
(iv) Estimation of free alkali present in different soaps/detergents

2. Redox Titrations: Principles of oxidation-reduction titrations (electrode potentials) to be discussed.

(i) Estimation of oxalic acid by titrating it with $KMnO_4$.
(ii) Estimation of Mohr's salt by titrating it with $KMnO_4$.
(iii) Estimation of oxalic acid and sodium oxalate in a given mixture.
(iv) Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal indicator (diphenylamine/ N-phenylanthranilic acid).

References:

Theory:

1. Lee, J.D.; (2010), **Concise Inorganic Chemistry**, Wiley India.
2. Huheey, J.E.; Keiter, E.A.; Keiter; R. L.; Medhi, O.K. (2009), **Inorganic Chemistry-Principles of Structure and Reactivity**, Pearson Education.
3. Douglas, B.E.; McDaniel, D.H.; Alexander, J.J. (1994), **Concepts and Models of Inorganic Chemistry**, John Wiley & Sons.
4. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A. (2010), **Shriver and Atkins Inorganic Chemistry**, 5th Edition, Oxford University Press.

Practicals:

- Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C. (1989), **Vogel's Textbook of Quantitative Chemical Analysis**, John Wiley and Sons.

Additional Resources:

1. Wulfsberg, G (2002), **Inorganic Chemistry**, Viva Books Private Limited.
2. Miessler, G.L.; Fischer P.J.; Tarr, D. A. (2014), **Inorganic Chemistry**, 5th Edition, Pearson.

GE 3: Chemistry: Bioinorganic Chemistry

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Bioinorganic Chemistry (GE-3)	4	2		2		Basic knowledge of Chemistry

Learning Objectives

The Learning Objectives of this course are as follows:

- To introduce students to bioinorganic chemistry, currently a frontier area of chemistry providing an interface between organic chemistry, inorganic chemistry and biology.
- To make students learn about the importance of inorganic chemical species, especially metals, in biological systems, through discussions on topics such as the sodium-potassium pump, the applications of iron in physiology, including iron transport and storage system, role of magnesium in energy production and chlorophyll, toxicity of heavy metal ions and their antidotes.

Learning Outcomes

By the end of the course, the students will be able to:

- Classify metal ions in biological systems as essential, non-essential, trace & toxic.
- Diagrammatically explain the working of the sodium-potassium pump in organisms and the factors affecting it
- Understand the role of metal ions such as Mg, Ca and Fe in biological systems.
- Understand the toxicity of heavy metal ions (Hg, Pb, Cd and As) in the physiological system
- Explain the use of chelating agents in medicine

SYLLABUS OF GE-3

Theory:

Unit 1: Introduction **(6 Hours)**

A brief introduction to bio-inorganic chemistry. Metal ions present in biological systems and their classification on the basis of action (essential, non-essential, trace & toxic). Classification of metallobiomolecules (enzymes, transport and storage proteins and non-proteins). Brief idea about membrane transport, channels, pumps.

Unit 2:Role of s-block Elements in Biological System **(8 Hours)**

Role of metal ions present in biological systems with special reference to Na^{+}, K^{+} and Mg^{2+} and Ca^{2+} ions: Na/K pump; Ca pump, role of Mg^{2+} ions in energy production and chlor ophyll. Role of calcium in bone formation.

Unit 3:Role of iron in Biological System **(8Hours)**

Role of iron in oxygen transport and storage (haemoglobin and myoglobin), Perutz mechanism, Cooperative effect, Bohr effect, comparison of oxygen saturation curves of haemoglobin and myoglobin, carbon monoxide. Storage and transport of iron in humans (ferritin and transferrin).

Unit 4: Toxicity of Heavy Metal Ions **(8 Hours)**

Toxicity of heavy metal ions (Hg, Pb, Cd and As), reasons for toxicity and their antidotes

Practicals: **(60 Hours)**

WEEKS)

(Laboratory Periods: 60)

1. Spectrophotometric estimation:

(i) Verify Lambert-Beer's law and determine the concentration of $CuSO_4$/$KMnO_4$/$K_2Cr_2O_7$/$CoSO_4$ in a solution of unknown concentration

(ii) Spectrophotometric estimation of Fe^{2+} ions by using 1, 10- phenanthroline

(iii) Determination of the composition of the Fe^{3+} - salicylic acid complex in solution by Job's method.

2. Complexometric titrations using disodium salt of EDTA:

(i) Estimation of Zn^{2+} using EBT / Xylenol orange as indicator

(ii) Estimation of Mg^{2+}

(iii) Estimation of Ca^{2+} by substitution method

(iv) To estimate the concentration of Ca in commercially available medicines.

(v) To estimate the Mg present in multivitamins.

References:

Theory:

1. Huheey, J.E.; Keiter, E.A., Keiter; R. L.; Medhi, O.K. (2009), **Inorganic Chemistry- Principles of Structure and Reactivity**, Pearson Education.
2. Shriver, D.D.; Atkins, P.; Langford, C.H. (1994), **Inorganic Chemistry** 2nd Ed., Oxford University Press.
3. Cotton, F.A.; Wilkinson, G.; Gaus, P.L. **Basic Inorganic Chemistry**, 3rd Edition,Wiley India.
4. Crichton, R.R. (2008), **Biological Inorganic Chemistry: An Introduction**. Amsterdam, Elsevier.
5. Kaim, W., B. Schwederski and A. Klein. (2014), **Bioinorganic Chemistry: Inorganic Elements in the Chemistry of Life: An Introduction and Guide.** 2nd Edition, Wiley.

Practical:

1. Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C. (1989), **Vogel's Textbook of Quantitative Chemical Analysis**, John Wiley and Sons.

Additional Resources:

1. Lippard, S.J.; Berg, J.M. (1994), **Principles of Bioinorganic Chemistry**, Panima Publishing Company.
2. Greenwood, N.N.; Earnshaw, A. (1997), **Chemistry of the Elements**, 2nd Edition, Elsevier

GE 4: Chemistry: Basic Concepts of Organic Chemistry

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Basic Concepts of Organic Chemistry (GE-4)	4	2		2		

Learning Objectives

The Learning Objectives of this course are as follows:

- To teach the fundamentals of organic chemistry and the introduction of a new concept of visualizing the organic molecules in a three- dimensional space.
- To establish the applications of these concepts, different types of organic reactions are introduced.

Learning Outcomes

By the end of the course, the students will be able to:

- Understand and explain the differential behavior of organic compounds based on fundamental concepts learnt.
- Formulate the mechanism of organic reactions by recalling and correlating the fundamental properties of the reactants involved.
- Learn and identify many organic reaction mechanisms including free radical substitution, electrophilic addition and electrophilic aromatic substitution.
- Differentiate between various types of organic reactions possible on the basis of reaction conditions

SYLLABUS OF GE-4

Theory:

Unit 1: Basic Concepts (6 Hours)

Electronic displacements and their applications: Inductive, electromeric, resonance and mesomeric effects and hyperconjugation. Dipole moment, acidity and basicity.
Homolytic and heterolytic fissions with suitable examples. Types, shape and relative stability of carbocations, carbanions and free radicals. Electrophiles and nucleophiles
Concept of Aromaticity: Huckel's rule

Unit 2: Stereochemistry (10 Hours)

Stereoisomerism: Optical activity and optical isomerism, asymmetry, chirality, enantiomers, diastereomers. specific rotation; Configuration and projection formulae: Newmann, Sawhorse, Fischer and their interconversion. Chirality in molecules with one and two stereocentres; meso configuration.
CIP rules: Erythro/Threo, D/L and R/S designations.
Geometrical isomerism: *cis-trans*, *syn-anti* and *E/Z* notations.

Unit 3: Types of Organic Reactions (14 Hours)

Introduction to substitution, addition, elimination, isomerization, rearrangement, oxidation and reduction reactions.
Free radical substitutions (Halogenation), concept of relative reactivity v/s selectivity. Free radical reactions in the biological reactions

Mechanisms of E1, E2, Saytzeff, Hoffmann eliminations and Cope elimination. Biological dehydration reactions

Electrophilic Additions reactions of alkenes and alkynes: mechanism with suitable examples, (Markownikoff/Antimarkownikoff addition), syn and anti-addition; addition of H_2, X_2, hydroboration-oxidation, ozonolysis, hydroxylation.

Nucleophilic substitution reactions – S_N1 and S_N2 mechanisms with stereochemical aspects and effect of solvent; nucleophilic substitution vs. elimination. Biological methylating agents

Electrophilic aromatic substitution: halogenation, nitration, sulphonation, Friedel Crafts alkylation/ acylation with their mechanism. Directing effects of groups in electrophilic substitution.

Practicals: (60 Hours)

(Laboratory Periods: 60)

1. Calibration of a thermometer and determination of the melting points of the organic compounds (Kjeldahl method, electrically heated melting point apparatus and BODMEL)
2. Purification of the organic compounds by crystallization using the following solvents:
3. a. Water b. Alcohol c. Alcohol-Water
4. Determination of boiling point of liquid compounds. (Boiling point lower than and more than 100 °C by distillation, capillary method and BODMEL)
5. Acetylation of one of the following compounds: amines (aniline, *o*-, *m*-, *p*- toluidines and *o*-, *m*-, *p*-anisidine) and phenols (*β*-naphthol, salicylic acid) either by conventional or green method.
6. Bromination of acetanilide/aniline/phenol either by conventional or green method.
7. Nitration of chlorobenzene/nitrobenzene.

References:

Theory:

1. Sykes, P. (2005), **A Guide Book to Mechanism in Organic Chemistry**, Orient Longman.
2. Eliel, E. L. (2000), **Stereochemistry of Carbon Compounds**, Tata McGraw Hill.
3. Morrison, R. N.; Boyd, R. N., Bhattacharjee, S.K. (2010), **Organic Chemistry**, 7th Edition, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. **Mehta B.; Mehta M. (2015),** Organic Chemistry**, PHI Learning Private Limited**
5. **Bahl, A; Bahl, B. S. (2012),** Advanced Organic Chemistry**, S. Chand.**

Practicals:

1. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. (2012), **Vogel's Textbook of Practical Organic Chemistry**, Pearson.
2. Mann, F.G.; Saunders, B.C. (2009), **Practical Organic Chemistry**, Pearson Education.

GE 7: Chemistry: States of Matter

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
States of Matter (GE-7)	4	2		2		

Learning Objectives

The Learning Objectives of this course are as follows:

- To make students learn about the properties of ideal and real gases deviation from ideal behaviour, properties of liquid, types of solids with details about crystal structure.
- To make student learn about the reaction rate, order, activation energy and theories of reaction rates.

Learning Outcomes

By the end of the course, the students will be able to:

- Derive ideal gas law from kinetic theory of gases and explain why the real gases deviate from ideal
- behaviour.
- Explain Maxwell-Boltzmann distribution, critical constants and viscosity of gases.
- Explain the properties of liquids especially surface tension and viscosity.
- Explain symmetry elements, crystal structure specially NaCl, KCl and CsCl
- Define rate of reactions and the factors that affect the rates of reaction.
- Understand the concept of rate laws e.g., order, molecularity, half-life and their determination
- Learn about various theories of reaction rates and how these account for experimental observations.

SYLLABUS OF GE-7

Theory:

Unit 1: Kinetic Theory of Gases **(12 Hours)**

Postulates of kinetic theory of gases and derivation of the kinetic gas equation, deviation of real gases from ideal behaviour, compressibility factor, causes of deviation, van der Waals equation of state for real gases. Boyle temperature (derivation not required), critical phenomena, critical constants and their calculation from van der Waals equation, Andrews isotherms of CO_2, Maxwell Boltzmann distribution laws of molecular velocities and molecular energies (graphic representation – derivation not required) and their importance. Temperature dependence of these distributions, most probable, average and root mean square velocities (no derivation), collision cross section, collision number, collision frequency, collision diameter and mean free path of molecules, viscosity of gases and effect of temperature and pressure on coefficient of viscosity (qualitative treatment only).

Unit 2: Liquids State (6 Hours)

Surface tension and its determination using stalagmometer, Viscosity of a liquid and determination of coefficient of viscosity using Ostwald viscometer, effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only). Effect of addition of various solutes on surface tension and viscosity. Explanation of cleansing action of detergents.

Unit 3: Solid State (12 Hours)

Forms of solids, symmetry elements, unit cells, crystal systems, Bravais lattice types and identification of lattice planes. Laws of crystallography - law of constancy of interfacial angles. Law of rational indices, Miller indices. X–ray diffraction by crystals, Bragg's law and powder XRD. Powder diffraction patterns of NaCl, CsCl and KCl (qualitative treatment only), defects in crystals. Glasses and liquid crystals.

Practicals: (60 Hours)

(Laboratory periods: 60)

1. Surface tension measurement (use of organic solvents excluded): Determination of the surface tension of a liquid or a dilute solution using a stalagmometer.
2. Viscosity measurement (use of organic solvents excluded):

a) Determination of the relative and absolute viscosity of a liquid or dilute solution using an Ostwald viscometer.
b) Study of the variation of viscosity of an aqueous solution with concentration of solute.

3. Solid State: Powder XRD

c) Differentiate and classify the given set of the diffraction pattern as crystalline materials or amorphous (Glass) substance.
d) Carry out analysis of a given set of powder XRD and determine the type of the cubic crystal structure
e) Determination of approximate crystal size from a given set of powder XRD

References:

Theory:

1. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A. (2010), **Shriver and Atkin's Inorganic Chemistry**, Oxford.
2. Miessler, G. L.; Tarr, D.A. (2014), **Inorganic Chemistry**, Pearson.
3. Castellan, G. W. (2004), **Physical Chemistry**, Narosa.

4. Kapoor, K.L. (2015), **A Textbook of Physical Chemistry**, Vol.1, 6th Edition, McGraw Hill Education.
5. Kapoor, K.L. (2015), **A Textbook of Physical Chemistry**, Vol.5, 3rd Edition, McGraw Hill Education.

Practicals:

1. Khosla, B.D.; Garg, V.C.;Gulati, A.(2015),**Senior Practical Physical Chemistry**, R. Chand & Co.

GE 9: Chemistry: Conductance and Electrochemistry

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Conductance and Electrochemistry (GE-9)	4	2		2		Basic knowledge of Chemistry

Learning Objectives

The Learning Objectives of this course are as follows:

- To make students learn about conductance, its measurement and applications.
- To make students learn the principles of electrochemical cells: Electrolytic and Galvanic cell, measurement of, measurement of emf and its applications.

Learning outcomes

By the end of the course, the students will be able to:

- Explain the factors that affect conductance, migration of ions and application of conductance measurement.
- Understand different types of galvanic cells, their Nernst equations, measurement of emf, calculations of thermodynamic properties and other parameters from the emf measurements.
- Understand applications of Emf measurements in relation to determination of activity coefficients, pH of a solution and Potentiometric titrations.

SYLLABUS OF GE-9

Theory:

Unit 1: Conductance (10 Hours)

Quantitative aspects of Faraday's laws of electrolysis. Arrhenius theory of electrolytic dissociation. Conductivity: equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes, Kohlrausch Law of independent migration of ions. Wein Effect and Debye–Falkanhegan Effect.

Transference number and its experimental determination using Hittorf and moving boundary methods, Ionic mobility, applications of conductance measurements: determination of degree of ionization of weak electrolytes, solubility and solubility products of sparingly soluble salts, ionic product of water, hydrolysis constant of a salt. Conductometric titrations (only acid-base).

Unit 2: Electrochemistry **(20 Hours)**

Reversible and irreversible cells with Examples, concept of EMF of a cell, measurement of EMF of a cell, Nernst equation and its importance, types of electrodes, standard electrode potential (reduction Potential) and its application to Gas–ion half-cell. Electrochemical series. Thermodynamics of a reversible cell, calculation of thermodynamic properties: G, H and S from EMF data. Calculation of equilibrium constant from EMF data. Concentration cells with transference and without transference, liquid junction potential; determination of activity coefficients and salt bridge, pH determination using hydrogen electrode. Potentiometric titrations-qualitative treatment (acid-base and oxidation-reduction only).

Practicals: **(60 Hours)**

(Laboratory periods: 60)

1. Conductance

(i) Determination of cell constant.

(ii) Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid.

(iii) Perform the following conductometric titrations:

a) Strong acid vs strong base

b) Weak acid vs strong base.

2. Potentiometry

Perform the potentiometric titrations of (i) Strong acid vs strong base, (ii) Weak acid vs strong base and (iii) Mohr's salt vs $KMnO_4$.

References:

Theory:

1. Castellan, G.W. (2004), **Physical Chemistry**, Narosa.
2. Kapoor, K.L. (2015), **A Textbook of Physical Chemistry**,Vol 1, 6th Edition, McGraw Hill Education.
3. Kapoor, K.L. (2013), **A Textbook of Physical Chemistry**,Vol 3, 3rd Edition, McGraw Hill Education.

Practicals:

1. Khosla, B.D.; Garg, V.C.;Gulati, A.(2015), **Senior Practical Physical Chemistry**, R. Chand & Co.

GE 11: Chemistry: Chemistry of Food Nutrients

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Chemistry of Food Nutrients (GE-11)	4	2		2		

Learning Objectives

The Learning Objective of this course is as follows:

- To help the students develop a basic understanding of the components of food, their source, properties and interactions as well as changes that occur during processing, storage, and utilization.

Learning Outcomes

On completion of the course, the student will be able to:

- Build a strong understanding of chemistry of food: composition of food, role of each component.
- Understand some of the reactions and changes in individual food components which occur during processing, handling and storage

SYLLABUS OF GE-11

Theory:

Unit 1: Carbohydrates (6 Hours)

Introduction, sources, functions, classification: monosaccharide, oligosaccharide and polysaccharide, structure and importance of polysaccharides in food chemistry (pectin, cellulose, starch, gums), chemical reactions of sugar: mutarotation, caramelisation; non enzymic browning and its prevention, role of carbohydrates as sweeteners in food.

Unit 2: Lipids (8 Hours)

Introduction, sources, classification (fatty acids, phospholipids, fats & oils, waxes), common fatty acids present in oils and fats, Omega- 3&6 fatty acids, trans fats, chemical properties- Reichert Meissel value, Polenski value, iodine value, peroxide value, saponification value, effect of frying on fats, changes in fats and oils- rancidity, lipolysis, flavor reversion, auto-oxidation and its prevention.

Unit 3: Proteins (8 Hours)

Introduction, sources, classification (simple, conjugated, derived), structure of protein (primary, secondary and tertiary), physico-chemical & functional properties of proteins, protein denaturation.

Unit 4: Vitamins & Minerals (8 Hours)

Vitamins: Introduction, classification: fat-soluble vitamins & water-soluble vitamins**.**

Minerals: Introduction, classification: macrominerals (Ca, P, Mg) & microminerals (Se, Fe, I, Co, Zn, Cu, Se, Cr).
Physiological importance of vitamins and minerals, effect of food processing on vitamins and minerals.

Practicals: (60 Hours)

(Laboratory periods: 60)

1. Determination of moisture in food products by hot air oven-drying method.
2. Colorimetric determination of Iron in vitamin / dietary tablets.
4. 2, 6-Dichlorophenol indophenol method for estimation of vitamin C in a given solution/ lemon Juice/chillies.
5. Estimation of total soluble sugar content by ferricyanide method (volumetric analysis).
6. Determination of saponification value of the given fat/oil.
7. Determination of iodine value of the given fat/oil.
8. Qualitative tests for proteins and carbohydrates.
9. Qualitative estimation of cholesterol by Liebermann Burchard method.

References:

Theory:

1. deMan, J.M., Finley, J.W., Hurst, W.J., Lee, C.Y. (2018), **Principles of Food Chemistry**, 4th Edition, Springer.
2. Msagati, T.A.M. (2013), **Chemistry of Food Additives and Preservatives**, Wiley-Blackwell.
3. Fennema, O.R. (2017), **Food Chemistry**, 5th Edition, CRC Press.
4. Attokaran, M. (2017), **Natural Food Flavors and Colorants**, 2nd Ed., Wiley-Blackwell.
5. Potter, N.N., Hotchkiss, J.H, (1995) **Food Science,** 5th Ed., Chapman & Hall.

6. Brannen, D., Davidsin, P.M., Salminen, T. Thorngate III, J.H. (2002), **Food Additives**, 2nd Edition, CRC Press.
7. Coultate, T. (2016), **Food: T he C hemistry o f i ts C omponents**, 6th Edn., Royal Society of Chemistry.
8. Belitz, H. D.; Grosch, W. (2009), **Food Chemistry**, Springer.
10. Course: FOOD CHEMISTRY (iasri.res.in)

Practical:

1. Ranganna, S. (2017). **Handbook of an alysis a nd q uality c ontrol f or f ruits an d vegetable products**, 2nd Edn., McGraw Hill Education
2. Sawhney, S.K., Singh, R. (2001), **Introductory P ractical B iochemistry**, Narosa Publishing House

GE 12: Chemistry: Statistical Methods and Data Analysis

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of th e course
		Lecture	Tutorial	Practical/ Practice		
Chemistry: Statistical Methods and Data Analysis (GE-12)	4	2		2		

Learning Objectives

The Learning Objectives of this course are as follows:

- To give the students insight about the statistical treatment on the chemical analysis data along with illustration about the analysis of collected analytical data that will help them to take up a job of technician, scientist and laboratory manager.
- To explain the presentation of data in different form such as “Table, Graph, Bar Diagram, Pie Chart, Venn diagram” along with their reliability and validity.

Learning Outcomes

At the end of this course student will be:

- Familiar with interpretation and use of analytical data collected by different techniques, significance of different analytical techniques and their applications, reliability and presentation of data for reporting to different forum.

SYLLABUS OF GE-12

Theory:

Unit 1: Basics of Chemical Analysis **(4 Hours)**

Analytical Chemistry, Qualitative and quantitative analysis, Analytical methodology. Calibration of glass wares, recording laboratory data.

Unit 2: Different Methods of Chemical Analysis **(8 Hours)**

Titrimetric method: volumetric titremetry, standard solution, titrimetric curve, calculation; Gravimetric method: precipitation gravimetry, calculation and applications of gravimetry; and Spectrometric methods: introduction, principle and instrument, working quantitative aspects absorbance, applications in chemical analysis

Unit 3: Statistical Method of Chemical Analysis **(8 Hours)**

Accuracy and Precision, Comparison of precision, Errors, Distribution of random errors, propagation of errors, measurement of errors, significant figure, inter laboratory error, methods of least square analysis of variance, Q test, Z test, T test, statistical treatment of finite sample, recommendations for treating outliers. Minimising errors in analytical procedure.

Unit 4: Data Analysis and Validation **(4 Hours)**

Confidence interval, Testing of hypothesis, plotting of data, least square method, Figures of merit: sensitivity, detection limit, linear dynamic range, control test, upper control limit and lower control limit, Validation, reporting analytical results and significant figures

Unit 5: Sampling, Standardisation, Labelling and Calibration **(6 Hours)**

Analytical samples, sample size, constituent sample, real samples, sample, sample handling, preparing laboratory samples, automated sample handling, lab on chip and General laboratory principles, recording laboratory data, standards, comparison of standards, internal standard, external standards calibration, least square method, and multivariant calibration.

Practicals: (60 Hours)

(Laboratory periods: 60)

1. Calibrate the volume of laboratory glass wares i.e. volumetric flask, beaker, burette and calibration constant.
2. Demonstrate the good laboratory practices like effect of dilution, temperature, taking observation, personal and apparatus safety.
3. Determine the quantitative presence of heavy metals like copper, chromium and iron in natural and laboratory samples using volumetric and gravimetric titration.
4. Determine the presence of magnesium ion in heavy water by EDTA method and prepare calibration curve.
5. Evaluate the absolute and method errors in a set of data collected during determination of nitrogen in an organic compound.
6. Calculate the standard deviation and predict precision of analytical results.

7. Determine the concentration of pollutant in natural sample after using external standards methods.
8. Compare the inter laboratory error of a spectroscopic results.
9. Evaluate the limit of detection for colorimetric analysis of dyes and coloured metals in wastes water samples.
10. Demonstrate the control of interference by masking by complexation.
11. Report the ten analytic results in significant numbers along with standard deviation.
12. Determine the confidence limit and interval for a laboratory instrument like breath alcohol analyser
13. Demonstrate the internal standard method for calibration of metal estimation.
14. Estimate the comparative effectiveness of different types of graphs like line, pi chart and bar graph.
15. Demonstrate the working of lab on chip like glucose sensor.

References:

1. Dey, R. A. and Underwood, A. L., **Quantitative Analysis**, 6th Edition, Pearson.
2. Skoog, D. A., West, D. M., Holler, F. J., Crouch, S. R., **Fundamental an alytical chemistry**, Thomson Asia Ltd.
3. Encyclopaedia of analytical chemistry: Applications, Theory, and Instrumentation, R A Meyor (Eds) Wiley and Sons (2000).

GE 13: Chemistry: Medicines in Daily Life

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Medicines in Daily Life (GE-13)	4	2		2		

Learning Objectives

The Learning Objectives of this course are as follows:

- To make students study the basic details about various medicines of general uses, which are crucial for the various diseases.
- To make students learn about the active pharmaceutical ingredient in some medicines, their synthesis; therapeutic effect and side effects on human physiology.

- To make students aware about the positive and negative effects of medicines those are essential for a healthy day-to-day life.

Learning Outcomes

By the end of the course, the students will be able to:

- Understand the role of different medicines on human physiology.
- Gain the knowledge of active pharmaceutical ingredient and their roles in different disease.
- Learn the proper use of different medicines and their effect and side effects.
- Learn the techniques of administering blood group, pulse rate, blood pressure and may other general diagnostic applications.

SYLLABUS OF GE-13

Theory:

Unit 1: General Introduction (8 Hours)

Introduction-Health, disease, drugs, chemotherapy, approaches in drug designing, classification of drugs and their origin.

Unit 2: Different class of medicines (22 Hours)

Structure of active ingredients, uses, dosage, side effects and their natural remedies:
Analgesics and antipyretics- Aspirin, paracetamol, ibuprofen, morphine, codeine
Antibiotics- Amoxicillin, norfloxacin, ciprofloxacin
Antihistamines or antiallergics- Cetrizine and Levocetrizine (role of stereoisomers)
Antiparasitic- Albendazole
Antidiabetics- Insulin, Glipizide and metformin
Antihypertensive – Amlodipine and its natural remedies- Rauwolfia.
Diuretic- Lasix
Antidepressant-Zoloft and its natural treatment
Antifungal – fluconazole, Itraconazole
Antacids- Ideal properties of antacids, combinations of antacids, Sodium 40 Bicarbonate, rantidine, milk of magnesia, aluminium hydroxide gel
Anticoagulants/antiplatelet drugs- Warfarin, heparin and Ecosprin
Anaesthetics- Atracurium, Desflurane
Poison and Antidote: Sodium thiosulphate, Activated charcoal, Sodium nitrite
Astringents: Zinc Sulphate, Potash Alum
Supplements- zinc and calcium, vitamins
Synthesis of small molecule drugs like aspirin and paracetamol

Practicals: (60 Hours)

(Laboratory periods: 60)

1. Determination of heart rate and pulse rate, blood pressure and discussion on medicines affecting them.
2. Identification test- Magnesium hydroxide, Sodium bicarbonate, Calcium gluconate.

3. Preparation of inorganic pharmaceuticals- Boric acid Potash alum
4. Determination of sugar content in the given solution.
5. Estimation of zinc and calcium in a given solution.
6. Qualitative analysis of carbohydrates (Glucose, Fructose, Lactose, Maltose, Sucrose).
7. Qualitative tests for Proteins
8. Qualitative analysis of vitamin C.
9. Isolation of paracetamol (API) from a commercial tablet
10. Isolation of aspirin (API) from tablet and recording of melting point (synthesis needs discussion)

References:

Theory:

1. Patrick, G. L. (2001) **Introduction t o Med icinal C hemistry**, Oxford University Press.
2. Lemke, T. L. & William, D. A. (2002), **Foye's Principles of Medicinal Chemistry**, 5th Ed., USA,
3. Singh H.; Kapoor V.K. (1996), **Medicinal and Pharmaceutical Chemistry**, Vallabh Prakashan.
4. Chatwal, G.R. (2010), **Pharmaceutical ch emistry**, inorganic (vol. 1), Himalayan publishing house
5. https://go.drugbank.com./

Practicals:

1. Jeffery, G.H., Bassett, J., Mendham, J., Denney, R.C. (1989), **Vogel's Textbook of Quantitative Chemical Analysis**, John Wiley and Sons.
2. Ahluwalia, V.K., Dhingra, S. (2004), **Comprehensive Practical Organic Chemistry: Qualitative Analysis**, University Press.
3. Munwar, S., Ammaji, S.(2019), **Comprehensive Practical Manual of Pharmaceutical Chemistry,** Educreation Publishing.
4. Mondal, P., Mondal, S.(2019), **Handbook of Practical Pharmaceutical Organic, Inorganic and Medicinal chemistry**, Educreation Publishing.

GE 15: Chemistry and Society

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Chemistry and Society (GE-15)	4	2		2		

Learning Objectives

The Learning Objectives of this course are as follows:

- To expand the literacy of chemistry, and increase general awareness, background of chemistry and its importance among the non-chemistry student even arts as well as commerce.
- To make a common student understand the importance and role of chemistry in development of civilization, societal issues related to chemistry and their expected solutions.

Learning Outcomes

At the end of this course the student will be able to:

- Increase the literacy of chemistry even in non-science students
- Understand the basic concept, principle and importance of chemistry
- Realize the importance of chemistry in daily life and future requirement

SYLLABUS OF GE-15

Theory:

Unit 1: Basics of chemistry (4 Hours)

Periodic table, Atom and molecules, chemical bonding, properties and chemical reactions with simple examples and illustration.

Unit 2: Chemistry in Heritage (8 Hours)

Extraction and uses of metals like iron and stone in ancient times, metals in ornaments, medicines, weapons and chemistry for preservatives, basics of preservation and few examples of preservatives.

Unit 3: Chemistry in Life (10 Hours)

Edible and non- edible molecules, biochemistry of foods and medicine with examples: Aspirin, Paracetamol. Ibuprofen and Penicillin, Cephalosporin, Chemistry for industry: Artificial sweeteners, Soaps and detergents and cosmetics, Polymer and Plastics: Uses and environmental issues.

Unit 4: Chemical pollution and Toxicity (2 Hours)

Chemical source of water, air and soil pollution, biomagnification and metal toxicity with example and illustrations. monitoring of air pollution.

Unit 5: Testing of chemicals (2 Hours)

Flame test, solubility test, qualitative and quantitative identification of ions in natural samples like metal copper, iron and chromium ores and adulterant in foods.

Unit 6: Future of chemistry (4 Hours)

Basics of green chemistry, Reuse and recycling of by-products, zero waste chemistry and Alternate fuel and energy providing chemicals: biodiesel, natural gas and hydrogen.

Practicals/Hands-on Training: **(60 Hours)**

(Laboratory periods: 60)

1. Determine the calcium and magnesium contents in water samples using EDTA methods.
2. Determine the organic contents and pH of soil sample.
3. Estimate the food adulterants in edible items
4. Quantify the presence metals by flame test method
5. Demonstrate the conversion of PET into bottle into value added products.
6. Determine the quantitative presence of heavy metals like copper and chromium in natural sample like ore.
7. Demonstrate the exothermic and endothermic reaction in laboratory
8. Preparation aspirin and paracetamol as well as identify.
9. Compare the fuel efficiency of biodiesel and petrol.
10. Preparation of representative compound using microwave
11. Demonstrate the biodegradability of natural and synthetic plastics.
12. Demonstrate the protection of rusting of iron after surface spray coating.
13. Estimate the protein contents in edible samples using chemical methods.
14. Small working project on heritage chemistry like bio compatibility of metals and medicinal importance of metals like iron, gold and silver.

References:

1. Lee, J. D., **Concise Inorganic Chemistry**, Wiley India Pvt. Ltd.
2. Sharma, B. K., **Industrial chemistry**, Goel Publishing House, India
3. Christian, Gary D., Dasgupta, Purnendu K., Schug, Kevin A., **Analytical chemistry**, Wiley
4. V. Subramanian, **A text book of Environmental chemistry**, Wiley

GE 19: Radio-chemistry in Energy, Medicine and Environment

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Radio-chemistry in Energy, Medicine and Environment (GE-19)	4	3		1		

Learning Objectives

The Learning Objectives of this course is as follows:

- To give an introduction to nuclear and radiochemical concepts to the students.
- To help students gain fundamental knowledge about the radioisotopes and their real-world applications in medicine, diagnostic techniques, energy, research and environment.

Learning Outcomes

By the end of the course, the students will:

- Learn about radioisotopes, radioactive decay
- Use of radiochemistry in various fields
- Effect of radiations on health
- Learn about nuclear energy and nuclear pollution

SYLLABUS OF GE-19

Theory:

Unit 1: Introduction (9 Hours)

Atoms, composition of nucleus, mass number, isotopes, nuclear stability, radioactive decay, radioactivity in nature: natural and artificial radioisotopes, elementary particles, radioactive decay (α, β and γ decay), half-life period, types of nuclear reactions: nuclear fission and nuclear fusion.

Unit 2: Nuclear power generation (6 Hours)

Nuclear Power generation from uranium ore (energy production and nuclear waste), introduction to nuclear reactors for energy and nuclear weapons

Unit 3: Applications of radiochemistry (15 Hours)

C 14 decay and radioactive dating, irradiation of food, radiotracers for studying chemical reactions (photosynthesis, metabolic studies of drugs, metabolism of organisms, fundamental properties of genetic material), medicinal application of radio chemicals in radiotherapy (use in cancer, hyperthyroidism, blood disorders), radio-pharmaceuticals, diagnostic procedures: CT, PET

Unit 4: Environment radioactivity (6 Hours)

Natural radioactivity, natural process that release radioactive material in environment, man-made events like Chernobyl disaster, bomb test, use of radiotracers in environmental studies.

Unit 5: Nuclear pollution and safety management (9 Hours)

Radiation protection standards, basics of radiation hazards, international guidelines on radiation protection, disposal of nuclear waste, nuclear disaster and it's managements, Effect of radiation on health: Biological effects of radiation, radiation monitors, dose limits for workers and public,

Practicals: **(30 Hours)**

(Laboratory periods: 30)

1. Study the background radiation in different places and identify the probable source. (Data to be provided).
2. Survey the diagnostic procedures involving radio-chemistry in different diagnostic laboratories.
3. Write a report on the radio isotopes used in various diagnostic procedures.
4. Write a report on safety measures taken in diagnostic labs.
5. Write a report on any two nuclear and radiation accidents focusing on their impact on human life, environment and economy.

References:

1. Nuclear and radiochemistry, Konya J., Nagy N. 2nd Edition, Elsevier
2. Radiochemistry and Nuclear Chemistry, 4th Edition, Choppin G., Lilijenzin J-O, Rydberg J., Ekberg C. Elsevier.

GE 21: Chemistry in Indology and Physical & Mental Well Being

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits		Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
			Lecture	Tutorial	Practical/ Practice		
Chemistry in Indology and Physical & Mental Well Being (GE-21)	4		3		1		

Learning Objectives

The Learning Objectives of this course is as follows:

- To illuminate the students about the scientific basis and approaches related to the practices that promote physical and mental health/balance, that includes meditation, sports, Yoga and nutrition. The chemical/biochemical mechanisms that underscore the various states of the mind and body, which drives the general homeostasis or anomalies thereof, shall also be illustrated.

- To make students aware about role of metals in ancient and medieval India
- To make students aware of how Alchemists used metals, chemicals, compounds and ores in medicines
- To make students aware of the different types of instruments used in the ancient and medieval India
- To make students aware of the life and work of ancient and medieval scientists/chemists.

Learning Outcomes:

By the end of the course, the students will:

- Understand about the scientific basis and approaches that promote physical and mental health.
- Know about the chemical/biochemical mechanisms that underline the states of the mind and body
- Understand the role of metals in ancient and medieval India
- Understand how alchemists used metals and chemical compounds in medicines
- Know about the life and contributions of ancient scientists and chemists

SYLLABUS OF GE-21

Theory:

Unit 1: Physical Health Practices (9 Hours)

Principles of Physical Education, Body composition with respect to health and fitness and different methods of body composition analysis, Calculation of energy expenditure (at rest and during exercise), VO_2 and calculation of VO_2 max, respiratory exchange ratio, blood pressure, Means of fitness development- aerobic and anaerobic exercises, yoga and physical fitness, Exercises and their intensities related to heart rate zone, Different fitness levels for different age groups and gender, Kinesiology, Physiology of Exercise

Unit 2: Mind-body Practices (6 Hours)

States of mind and types of brain waves, mindfulness meditation in clinical psychology and psychiatry, Desbordes' recent studies on brain activities (Harvard's studies), MRI & functional MRI studies.

Types of meditations- focused attention meditation (FA), open monitoring meditation (OM), transcendental meditation (TM), loving–kindness meditation (LKM), mindfulness meditation (MM) and body–mind meditation (B-M).
Biochemical alterations, such as changes in activity/production of hormones, cytokines, chemokines, interferons, etc., oxygen saturation/desaturation, redox-condition and oxidative balance, progression/regression of certain diseases/health conditions, in response to various states of physical and mental well-being.

Unit 3: Nutrition for Mind/body Homeostasis (6 Hours)

Role of nutrition in physical and mental health. Nutrients: carbohydrates, Protein, Fat, Vitamins, Minerals, Water-their functions, role of hydration (water balance) during exercise, daily caloric requirement and expenditure.
Metabolism: An overview of ATP release in glycolysis, TCA cycle, electron transport chain. basic concept of balanced diet vs. fad diet (Atkins, ketogenic etc.), Concept of BMI (Body mass index) and BMR (Basal metabolic rate), Obesity and its hazard, Dieting versus exercise for weight control.

Unit 4: Concepts of Atoms, Molecules and Laws of Motion (3 Hours)

Concepts of atoms and molecules, properties and categories of atoms and molecules, Laws of motion.

Unit 5: Metallurgy (6 Hours)

Gold, Silver, Copper, Bronze and other alloys; Copper smelting blast furnace and copper extraction; Tron and Steel; Iron smelting blast furnaces from Southern India; Ironworks in Ancient and medieval India; Delhi Iron Pillar; Dhar and Kodachadri Iron pillars; Wootz steel; Zinc and its extraction.

Unit 6: Chemicals (3 Hours)

Drugs, dyes, pigments, glass, cosmetics and perfumes, etc.

Unit 7: Drugs (6 Hours)

Eight categories of Gandhasara; Compounds of mercury (Hg) made and used by the Indian Alchemists for medicinal purposes; Use of chemical, compounds and ores in medicines.

Unit 8: Life and work of Ancient Indian Scientists/Chemists (6 Hours)

(i) Maharshi Kanada (Ancient text and manuscripts), (ii) Nagarjuna (Ras Ratnakar, Kakshaputtantra, Arogya Manjari, Yog Saar, Yoasthak), (iii) Vaagbhatt (Rasratna Samuchchay), (iv) Govindacharya (Rasarnava), (v) Yashodhar (Ras Prakash Sudhakar), (vi) Ramachandra (Rasendra Chintamani), (vii) Somdev (Rasendra Chudamani)

Practicals: (30 Hours)

(Laboratory periods: 30)

1. Extraction of essential oil from rose petal.
2. Extraction of casein from milk.
3. Determination of pulse rate/blood pressure/oxygen saturation before and after exercise.
4. Determination of acid value of given oil sample.
5. Isolation of piperine from black pepper.
6. Determination of Copper in a brass turnings.
7. Extraction of Butea monosperma (Palash) dye for its use in coloration of cloth.
8. Determination of mass loss in mild steel in acidic/basic media.
9. **Project on (Do any one):**
   Ayurveda as alternate medicine system,
   Homeopathy in India,
   Yogic Practices for mental wellness
   Ancient Chemists of India
   Other titles can also be suggested by the teacher.
10. **Visit to**
    Iron Pillar, the metallurgical marvel and prepare a brief report.
    Industries like Dabur India Ltd.

References:

1. Baer cites Kabat-Zinn, J. (1994): **Wherever you go, there you are: Mindfulness meditation in everyday life.** New York: Hyperion, p.4.
2. Buchholz L (October 2015). "**Exploring the Promise of Mindfulness as Medicine**". JAMA. 314 (13): 1327–1329. doi:10.1001/jama.2015.7023. PMID 26441167.
3. Harrington A, Dunne JD (October 2015). "**When mindfulness is therapy: Ethical qualms, historical perspectives**". The American Psychologist. 70 (7): 621–631. doi:10.1037/a0039460. PMID 26436312.
4. Blanck P, Perleth S, Heidenreich T, Kröger P, Ditzen B, Bents H, Mander J (March 2018). "**Effects of mindfulness exercises as stand-alone intervention on symptoms of anxiety and depression: Systematic review and meta-analysis**". Behaviour Research and Therapy. 102: 25–35. doi:10.1007/s12671-014-0379-y. PMID 29291584.
5. Khoury B, Sharma M, Rush SE, Fournier C (June 2015). "**Mindfulness-based stress reduction for healthy individuals: A meta-analysis**". Journal of Psychosomatic Research. 78 (6): 519–528. doi:10.1016/j.jpsychores.2015.03.009. PMID 25818837.
6. Jain FA, Walsh RN, Eisendrath SJ, Christensen S, Rael Cahn B (2015). "**Critical analysis of the efficacy of meditation therapies for acute and subacute phase treatment of depressive disorders: a systematic review**". Psychosomatics. 56 (2): 140–152. doi:10.1016/j.psym.2014.10.007. PMC 4383597. PMID 25591492.
7. Reangsing C, Punsuwun S, Schneider JK (March 2021). "**Effects of mindfulness interventions on depressive symptoms in adolescents: A meta-analysis**". International Journal of Nursing Studies. 115: 103848. doi:10.1016/j.ijnurstu.2020.103848. PMID 33383273. S2CID 229940390.

8. Sharma M, Rush SE (October 2014). "**Mindfulness-based stress reduction as a stress management intervention for healthy individuals: a systematic review**". Journal of Evidence-Based Complementary & Alternative Medicine. 19 (4): 271–286. doi:10.1177/2156587214543143. PMID 25053754.
9. Hofmann SG, Sawyer AT, Witt AA, Oh D (April 2010). "**The effect of mindfulness-based therapy on anxiety and depression: A meta-analytic review**". Journal of Consulting and Clinical Psychology. 78 (2): 169–183. doi:10.1037/a0018555. PMC 2848393. PMID 20350028.
10. Chiesa A, Serretti A (April 2014). "**Are mindfulness-based interventions effective for substance use disorders? A systematic review of the evidence**". Substance Use & Misuse. 49 (5): 492–512. doi:10.3109/10826084.2013.770027. PMID 23461667. S2CID 34990668.
11. Garland EL, Froeliger B, Howard MO (January 2014). "**Mindfulness training targets neurocognitive mechanisms of addiction at the attention-appraisal emotion interface**". Frontiers in Psychiatry. 4: 173. doi:10.3389/fpsyt.2013.00173. PMC 3887509. PMID 24454293.
12. Sancho M, De Gracia M, Rodríguez RC, Mallorquí-Bagué N, Sánchez-González J, Trujols J, et al. (2018). "**Mindfulness-Based Interventions for the Treatment of Substance and Behavioral Addictions: A Systematic Review**". Frontiers in Psychiatry. 9 (95): 95. doi:10.3389/fpsyt.2018.00095. PMC 5884944. PMID 29651257.
13. Paulus MP (January 2016). "**Neural Basis of Mindfulness Interventions that Moderate the Impact of Stress on the Brain**". Neuropsychopharmacology. 41 (1): 373. doi:10.1038/npp.2015.239. PMC 4677133. PMID 26657952.
14. Dunning DL, Griffiths K, Kuyken W, Crane C, Foulkes L, Parker J, Dalgleish T (March 2019). "**Research Review: The effects of mindfulness-based interventions on cognition and mental health in children and adolescents - a metaanalysis of randomized controlled trials**". Journal of Child Psychology and Psychiatry, and Allied Disciplines. 60 (3): 244–258. doi:10.1111/jcpp.12980. PMC 6546608. PMID 30345511.
15. Sharman, J. R. (1964). **Introduction to physical education**. New York: A.S. Barnes & Co.
16. William, J. F. (1964). **The principles of physical education. Philadelphia**: W.B. Saunders Co
17. Bucher, C. A. (n.d.) **Foundation of physical education.** St. Louis: The C.V. Mosby Co.
18. Sharkey, B. J. (1990). **Physiology of fitness**, Human Kinetics Book
19. Giam, C.K & The, K.C. (1994). **Sport medicine exercise and fitness**. Singapore: P.G. Medical Book.
20. Kenney, W.L., Wilmore, J.H., Costill, D.L. (six edition) **Physiology of sport and exercise.**
21. Vedas: (i) Rig Veda, (ii) Yajur Veda, (iii) Atharva Veda, (iv) Sama Veda
22. Deb, B. M., **The Peacock in Splendour**, Visva Bharti University.
23. Ray, P. C., **A History of Hindu Chemistry: from the Earliest Times to the Middle of the Sixteenth Century A.D.**, Volume 1 – 1902, Volume 2 – 1908, The Bengal Chemical and Pharmaceutical Works Ltd

24. "**History of Chemistry in Ancient and Mideaval India**" (Edited volume of Acharya Ray's "History of Hindu Chemistry"), Indian Chemical Society, Calcutta, 1956.
25. Harsha, N. M., Nagaraja, T. N., **The History of Hindu Chemistry**, Ancient Science of Life, 2010, 30, 58 – 61.
26. Ray, P. C., **Life and experiences of a Bengali chemist,** Two Volume Set. Calcutta: Chuckervertty, Chatterjee & Co. 1932 and 1935.
27. Ray, P. R., **Chemistry in Ancient India**, Journal of Chemical Education, 1948, 25 (6), 327.
28. Seal, B. N.(1915), **The Positive Sciences of the Ancient Hindus**, Longman Greens and Co., Kolkata.

BHASKARACHARYA COLLEGE OF APPLIED SCIENCE
B.Sc. (HONOURS) POLYMER SCIENCE

Category I

DISCIPLINE SPECIFIC CORE COURSE -1 (DSC-1) – :
INTRODUCTION TO POLYMER SCIENCE

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
INTRODUCTION TO POLYMER SCIENCE	4	3	0	1	PCM	PCM

Learning Objectives

The Learning Objectives of this course are as follows:
- To familiarize with the structure of polymers.
- To acquaint students with knowledge of molecular weight determination and polymersolubility.

Learning outcomes

The Learning Outcomes of this course are as follows:
- Understand physical state of polymers
- Develop fundamental knowledge of thermal transitions of temperature
- Understand structure-property relationship of polymers
- Apply mathematical formulae to depict polymer solution properties

SYLLABUS OF DSC-1
UNIT – I (9 hours)

INTRODUCTION TO POLYMER SCIENCES

Introduction and history of polymeric materials, classification of polymers, configuration and conformation of polymers, nature of molecular interaction in polymers, cumulative interaction, entanglement, random chain model and RMS end-to-end distance, Various structures of copolymers such as linear branched and cross-linked copolymers and their types.

UNIT – II (6 hours)
POLYMER CRYSTALS

Crystal morphologies, extended chain crystals, chain folding, lamellae, spherulites, crystallization, crystallinity, crystallizability & orientation, crystalline melting point, crystallization kinetics, effect of orientation and crystallinity on polymer properties, determination of crystallinity.

UNIT – III (9 hours)
PROPERTIES OF POLYMERS

Physical properties, introduction of mechanical properties (stress–strain curves, tensile, flexural, impact, fatigue, hardness, creep and abrasion), electrical properties (dielectric strength, volume resistivity and power factor)

UNIT – IV (9 hours)
POLYMER MOLECULAR WEIGHT
Nature and structure of polymers: structure-property relationships, molecular weight of polymers (Mn, Mw, MV and MZ), polydispersity, molecular weight distribution and determination of molecular weight by solution viscosity and end group analysis,

UNIT – V (6 hours)
SOLUTION PROPERTIES OF POLYMERS
Polymer solutions, solubility parameter, athermal solvents, theta solvents, solutionviscosity, thermodynamics of polymer solutions, Flory-Huggins theory

UNIT – VI (6 hours)
GLASS TRANSITION BEHAVIOUR OF POLYMERS
Glass transition temperature (Tg) and measurement of Tg, factors affecting the glass transition temperature, WLF equation

Practical component – (30 hours)

1. Chemical identification of polymers- • Unsaturation • Testing of functional groups(associated with polymers).
2. Measurement of glass transition temperature (Tg).
3. To determine the melting point of crystalline polymers.
4. To check the solubility of the given polymeric sample in different solvents.
5. Determination of molecular weight by solution viscosity.
6. Determination of number average molecular weight by end group analysis.
7. To find out the acid number and hydroxyl number of a given polymer.
8. To measure volume resistivity of polymer samples.

Essential/recommended readings

1. Odian, G., (2004) Principles of Polymerization, Wiley-interscience.
2. Gowarikar V.R., (2019) Polymer Science, New Age International Publishers Ltd, 3rdEdition.
3. Billmeyer F.W., (2007) Textbook of Polymer Science, Wiley, India.
4. Shah V., (1998) Handbook of Plastics Testing Technology, Wiley Interscience.

5. Seymour R.B., Carraher C.E., (2003) Polymer Chemistry, Marcel Dekker.
6. Teraoka, I. (2002). Polymer solutions: an introduction to physical properties.
7. Hiemenz, P. C., & Lodge, T. P. (2007). Polymer chemistry. CRC press.

Suggestive readings

1. Brydson J.A., (2016) Plastics Materials, Butterworth Heinemann, 8th Edition.
2. Schultz J.M., (2001) Polymer Crystallization, American Chemical Society.
3. Ghosh P., (2010) Polymer Science and Technology: Plastics, Rubbers, Blends andComposites, Tata McGraw Hill.
4. Shah V., (2006) Handbook of Plastics Testing and Failure Analysis,John Wiley & Sons,Inc., 3rd Edition.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 2 (DSC-2): RAW MATERIALS FOR POLYMERS

Credit distribution, Eligibility and Prerequisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
RAW MATERIALS FOR POLYMERS	4	3	0	1	PCM	

Learning Objectives

The Learning Objectives of this course are as follows:

- To learn about the resources of polymers
- To learn about basic concepts of polymer latex
- To gain knowledge of properties of monomers and their synthesis XXX

Learning outcomes

The Learning Outcomes of this course are as follows:

- Apply the knowledge of latex manufacturing and compounding
- Apply the knowledge of techniques used in monomer production

SYLLABUS OF DSC- 2

UNIT – I (6 hours)

INTRODUCTION TO CRUDE OIL AND IT'S REFINING

Petroleum oil, natural gas, coal: capabilities and limitations. general consideration of petrochemicals, an overview of petroleum refining, desalting, distillation, cracking and its types

UNIT – II (15 hours)

SYNTHESIS OF MONOMERS FROM PETROCHEMICALS

Ethylene, vinyl acetate, vinyl chloride, ethylene oxide and ethylene glycol, acrylonitrile, methyl methacrylate, isoprene, phenol, styrene, terephthalic acid, adipic acid, caprolactam, hexamethylenediamine

UNIT – III (6 hours)

LATEX

Natural rubber latex: collection process, composition, concentration and stabilization of latex

UNIT – IV (9 hours)

LATEX ADDITIVES AND IT'S COMPOUNDING

Vulcanizing agents, fillers, accelerator, coagulating agent, wetting, dispersing and emulsifying agents, stabilizers, thickening agents and other additives, compounding formulations for product manufacturing

UNIT –V (9 hours)

LATEX PRODUCT MANUFACTURING TECHNIQUES

Latex compound formulation, process of manufacturing, finishing and applications of spreading, casting and dipping (Dipping-principle and procedure of dipping process- different types of dipping –after treatment of latex deposits -Manufacture of dipped goods with formulation and flow chart-defects and remedies . latex casting – principle and procedure of casting-production of cast articles –mould preparation, latex thread and latex foam

Practical component- (30 hours)

1. Analysis of formalin/phenol/epichlorohydrin/Plasticizer
2. Determination of hydroxyl value/carboxyl value/ester value/epoxy value
3. Determination of colour and viscosity by gardner’s tube method
4. Fractional distillation of crude oil.
5. To calculate dry rubber content (DRC) of latex.
6. To determine the coagulation strength of latex.
7. Preparation of balloon by dipping process.
8. Latex compounding for preparation of gloves & balloons.
9. Synthesis of adipic acid from cyclohexanol using Conc. HNO3.
10. To prepare monomers from C4 hydrocarbons.
11. Determination of percentage purity of phenol.

Essential/recommended readings

1. Kumar D., Chandra R., (2001) Latex Technology, Dhanpat Rai & Co.
2. Rao B.K.B., (2007) Textbook on Petrochemicals, Khanna Publishers.

3. Blackley, D.C., “High Polymer Latices”, Vol 1 and 2, Chapman and Hall, 1997
4. Mausser,R.F., “The Vanderbilt Latex Hand book” 3rd edn.R.T. Vanderbilt Company,1987.

Suggestive readings

1. Rao B.K.B., (2007) Modern Petroleum Refining Processes, Oxford and IBH
2. Maiti S., (2002) Introduction to Petrochemicals, Oxford & IBH Publ. Co.
3. Speight J.G., (2006) Chemistry and Technology of Petroleum, CRC Press.
4. Martin J. M., Smith W.K., (2007) Handbook of Rubber Technology, CBS Publishers.

DISCIPLINE SPECIFIC CORE COURSE– 3 (DSC-3): UNIT OPERATIONS

Credit distribution, Eligibility and Pre-requisites of the Course

Course title& Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
UNIT OPERATIONS	4	3	0	1	PCM	PCM

Learning Objectives

The Learning Objectives of this course are as follows:

- To understand concepts of unit operations and their importance in polymer industries
- To learn about the concepts of separation equipments used in the process industry XXX

Learning outcomes

The Learning Outcomes of this course are as follows:

- Select suitable criteria for solving material and energy balance problems
- Illustrate energy and material balance equations for open and closed systems

SYLLABUS OF DSC-3

UNIT – I (6 hours)

INTRODUCTION TO UNIT OPERATIONS

Unit operations: concept and requirement, material and energy balances (with and without chemical reactions), energy transport in non-isothermal systems

UNIT – II (9 hours)

MECHANICAL OPERATIONS

Mechanical Operations: Size reduction and its equipment (ball mill, jack crusher, end and edge roller mill), filtration: theory of filtration, filter aids, filter media, industrial filters including filter press, rotary filter, edge filter, etc., factors affecting filtration

UNIT – III (15 hours)

HEAT TRANSFER

Conduction (Fourier law, Reynolds number), convection, radiation, heat exchangers (tube shell, shell plate)

UNIT – IV (15 hours)

MASS TRANSFER MECHANISM

Mass diffusion, factors affecting diffusion, gas absorption (Henry's Law, Langmuir Absorption Isotherm, BET equation), types of distillation, drying

Practical component (30 hours)

1. Handling of jaw crusher, ball mill for crushing and grinding.
2. Calculate the rate of evaporations of different volatile liquids.
3. Distillation of various liquid mixtures.
4. To evaluate diffusion percentage of a plasticizer in a PVC.
5. Filtration of solids from slurry.
6. Calculation of pressure drop and pipe size.
7. Heat Transfer through different materials like glass and plastics.
8. Analysis of different adsorption isotherms.

Essential/recommended readings

1. Mccabe W., Smith J., Harriott P., (2005) Unit Operations in Chemical Engg., McGraw-Hill Education.
2. Chattopadhaya P., (2003) Unit Operations in Chemical Engg., Vol. 1 & Vol. 2, KhannaPublishers.
3. Coulsan J.M., Richardson J.F., (2010) Chemical Engg., Vol. 1, Elsevier.

Suggestive readings

1. Kumar D. S., (2009) Heat and Mass Transfer, S K Kataria & Sons.
2. Rao G. K., (2002) Solved Example in Chemical Engg., Khanna Publishers.
3. Treybal R., (2012) Mass Transfer Operations, Tata McGraw Hill.

COMMON POOL OF GENERIC ELECTIVE COURSES OFFERED BY BHASKARACHARYA COLLEGE OF APPLIED SCIENCES IN POLYMER SCIENCE

GENERIC ELECTIVES (GE-1): BASICS OF POLYMER SCIENCE

Category-IV

Credit distribution, Eligibility and Pre-requisites of the Course

Course title &Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course	Department offering t he course
		Lecture	Tutorial	Practical/ Practice			
BASICS OF POLYMER SCIENCE	**4**	**2**	**0**	**2**	**All Science Streams**	NIL	**Polymer Science**

Learning Objectives

The Learning Objectives of this course are as follows:

- To familiarize with the structure of polymers will be introduced to students.
- To acquaint students with knowledge of molecular weight determination and polymersolubility

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand concept of crystalline and amorphous states of polymers
- Correlate flexibility with the glass transition temperature
- Understand structure-property relationship of polymers
- Apply mathematical formulae to depict polymer solution properties

SYLLABUS OF GE-1

UNIT – I (10 hours)

INTRODUCTION TO POLYMERS

Introduction and classification of polymers, configuration and conformation of polymers, nature of molecular interaction in polymers, entanglement, various structures of copolymers such as linear branched and cross-linked copolymers, Polymer solutions, solubility parameter, solution viscosity, polymer solubility, thermodynamics of polymersolutions

UNIT – II (10 hours)
PROPERTIES OF POLYMERS
Physical properties, stress–strain behaviour, mechanical properties (tensile, flexural, impact, fatigue, hardness, creep, abrasion), introduction to flow & glass transition temperature (Tg) and its measurement of Tg, factors affecting the glass transition temperature

UNIT – III (10 hours)
MOLECULAR WEIGHT OF POLYMERS
Nature and structure of polymers – structure-property relationships, Molecular weight of polymers (Mn, Mw etc.), polydispersity, molecular weight distribution and determination of molecular weight by viscosity, end group analysis, cryoscopy, ebulliometry, light scattering & ultracentrifugation methods

Practical component (60 hours)

1. Chemical identification of polymers: Functional groups (associated with polymers).
2. Determination of molecular weight by solution viscosity/end group analysis.
3. To check the solubility of the given polymeric sample in different solvents.
4. To determine the melting point of crystalline polymers.
5. Determination of heat deflection temperature & vicat softening point of polymers.
6. Acid value of acrylic acid
7. Estimation of hydroxyl value by PVA and Cyclohexanol
8. Determination of epoxy equivalent weight of the epoxy resin.
9. Determination of saponification value of oil.
10. Study of three component systems.

Essential/recommended readings

1. Brydson J.A., (2016) Plastics Materials, Butterworth Heinemann, 8th Edition.
2. Ghosh P., (2010) Polymer Science and Technology: Plastics, Rubbers, Blends andComposites Tata McGraw-Hill.
3. Gowarikar V.R., (2019) Polymer Science, New Age International Publishers Ltd, 3rd Edition
4. Billmeyer F.W., (2007) Textbook of Polymer Science, Wiley, India.
5. Shah V., (1998) Handbook of Plastics Testing Technology, Wiley interscience publications

Suggestive readings

1. Schultz J.M., (2001) Polymer Crystallization, American Chemical Society.
2. Seymour R.B., Carraher C.E., (2000) Polymer Chemistry, Marcel Dekker.

GENERIC ELECTIVES (GE-2): ADVANCED ANALYTICAL TECHNIQUES

Credit distribution, Eligibility and Pre-requisites of the Course

Course title& Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisiteof the course
		Lecture	Tutorial	Practical/ Practice		
ADVANCED ANALYTICAL TECHNIQUES	4	2	0	2	All Science Streams	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To acquaint the students with the advanced instrumental techniques and theirapplications in characterization of polymeric materials

Learning outcomes

The Learning Outcomes of this course are as follows:

- Learn the electronic microscope for characterization of morphology of polymeric materials
- Elucidate crystallinity of various polymers and their characterization on the basis of theirthermal stability and glass transition temperature

SYLLABUS OF GE-2UNIT – I (6 hours)
INTRODUCTION
Basic principle of spectroscopy, molecular and atomic spectra, Lambert-Beer's law, Frank-condon principle, electromagnetic radiation and it's properties, interaction of radiation with matter, statistical method of analysis

UNIT – II (6 hours)
SPECTROSCOPIC TECHNIQUES
Principles and applications in structural determination of polymers (functional group, tacticity, molecular structure, purity, unsaturation etc.): Infra-red spectroscopy, UV-Vis spectroscopy, electron spin resonance, raman, nuclear magnetic resonance spectrometer

UNIT – III (8 hours)
CHROMATOGRAPHY TECHNIQUES IN POLYMER
Thin layer chromatography, high performance liquid chromatography, gel permeation chromatography (GPC), gas chromatography.

UNIT – IV (10 hours)

MICROSCOPIC AND X-RAY TECHNIQUES

Optical microscopy, electron microscopy (SEM, TEM, AFM) and XRD: basics and applications (size, morphology, crystallinity etc.) in polymers characterization

Practical component- (60 hours)

1. Study of UV stabilization of polymer samples by UV-visible spectrophotometer.
2. Calculate weight percentage of inorganic and organic ingredients in polymeric compounds.
3. Determination of K-value of PVC.
4. Quantitative determination of impurities by UV-Vis. spectrophotometer.
5. Characterization of Filler Content /Ash Content of common polymers byThermogravimetric Analysis, (TGA).
6. Dentification of additives in a processed polymer by chromatography.
7. Interpretation of FTIR, NMR and Raman spectra of polymers

Essential/recommended readings

1. Willard H.H., Merritt L.L., Dean J.A. (1988) Instrumental method of analysis, Wads worth Publishing Company.
2. Skoog D.A, (1997) Principle of Instrumental Analysis, Harcourt College Pub.
3. Shah V., (2007) Handbook of Plastic Testing, Technology, Wiley-Inter science.
4. Banwell C.N., McCash E.M., (2008) Fundamentals of Molecular Spectroscopy,Fourth Edition, Tata McGraw-Hill.

Suggestive readings -

1. Tanaka T., (1999) Experimental Methods in Polymer Sciences, Academic Press.
2. Silverstein R.M., (1991) Spectrometric identification of organic compounds, JohnWiley.
3. Macomber R.S., (2008) A complete introduction to NMR spectroscopy, Wiley-interscience.

GENERIC ELECTIVES (GE-3): POLYMERS AND ENVIRONMENT

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
POLYMERS AND ENVIRONMENT	**4**	**2**	**0**	**2**	**All Science Streams**	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To give understanding of basics of care to be taken while handling polymer products.
- To know the Safety and hazardous of their manufacturing processes.
- To impart Knowledge of the subject will help students to see the environmental impact of plastic and resin.
- To understand the current benefits and concerns surrounding the use of plastics and look to future priorities, challenges and opportunities.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand basics of environmental and safety issues in the chemical industry.
- Understand safety in handling monomer and resins
- Impact of final product of polymer on environment after use and its waste management

SYLLABUS OF GE-3

UNIT – I (8 hours)
ENVIRONMENTAL APPROACH OF PLASTIC WASTE

Health and safety, Plastics in the society, Plastics in the environment, Plastic waste management, Plastic waste in the marine and terrestrial environment, Plastic material degradation, regulations for hazardous chemicals in articles/plastic products, coated articles. Separation techniques of plastic wastes (density, float sink and froth floatation methods, optical, spectroscopic, sorting by melting temperature etc.).

UNIT – II (8 hours)
PLASTIC SEGREGATION

Thermoplastic waste management: 4 R's approach (reduce, reuse, recycle (mechanical and chemical), recover), recycling classification- - primary - secondary - tertiary - quaternary recycling with examples.

UNIT – III (14 hours)
RECYCLING

Disposal processes and Various waste treatment methods – controlled tipping, pulverization, compositing, Energy from waste – (incinerators- pyrolysis, factors affecting incineration), new developments in thermal disposal of refuse, on-site disposal methods, compacting and baling. Recycling of Polyolefins, PVC, PET, Polystyrene, Polyamides (Nylon-6 and Nylon- 6,6). Recycling of Thermosets –reclaiming of rubber –pyrolysis, depolymerization of scrap rubber, tyre retreading, uses of recycled rubber.

Practical component- (60 hours)

1. Primary recycling of plastic waste collected from the environment.
2. Secondary recycling of MSW by incorporating and blending the recyclable waste with virgin polymers.
3. To study composting of natural/biopolymers.
4. Separation of polymer mixture by sink flotation technique.
5. Separation of polymer mixture by selective dissolution technique.
6. Recovery of BHET from PET by chemical recycling process
7. Recovery of Adipic Acid from Nylon 66 by chemical recycling technique
8. To study the effect of vulcanized rubber at varying ratio (in powder form) on mechanical properties of rubber vulcanizate
9. Preparation of plasticizer from polyester waste.
10. Preparation of reclaim from tyre waste.

Essential/recommended readings

1. Chandra, R., & Adab, A. (1994). Rubber & Plastic Waste: Recycling, Reuse and Future Demand. CBD Publishers.
2. Scheirs, J., & Long, T. E. (Eds.). (2005). Modern polyesters: chemistry and technology of polyesters and copolyesters. John Wiley & Sons.

Suggestive readings

1. Blow, S. (1998). Handbook of Rubber Technology.
2. Brandrup, J., Bittner, M., Michaeli, W., & Menges, G. (1996). Recycling and Recovery of Plastics, Hanser. Gardner, München.
3. Goodship, V. (2007). Introduction to plastics recycling. iSmithers Rapra Publishing.
4. Brydson J.A., (2016) Plastics Materials, Butterworth Heinemann, 8th Edition

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

Sri Venkateswara College

COURSES OFFERED BY DEPARTMENT OF
BOTANY, BIOCHEMISTRY, ZOOLOGY, CHEMISTRY AND PHYSICS

B.Sc. (Hons.) Biological Science

Category-I

DISCIPLINE SPECIFIC CORE COURSE – 01: Basic concepts of Biomolecules

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (If any)
		Lecture	Tutorial	Practical/ Practice		
Basic concepts of Biomolecules	**DSC-101**	**2**	**0**	**2**	10+2 from any recognized Board with Biology & Candidates must appear in CUET in the following subject combination: **Physics+ Chemistry+ Biotechnology Biology/**	**Nil**

Learning Objectives

The Learning Objectives of this course are as follows:

- to develop a basic understanding of the structure, bonding, stability, stereochemistry and reactivity of organic molecules with focus on biomolecules.
- This basic knowledge will empower the students to develop an understanding about chemistry and biology of biomolecules such as proteins and nucleic acids. This course also provides a basic understanding of the chemistry of carbohydrates and lipids.
- This knowledge will help students to better understand the biological applications of these biomolecules.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand and apply the fundamental principles of chemistry which include bonding, electronic effects, molecular forces and stability of reactive intermediates tobiomolecules.
- Gain an insight into the influence of chemical bond polarization on a molecularstructure and its reactivity.
- Identify the type of metabolic reaction and draw reaction mechanisms for keymetabolic processes.
- Recognize stereochemistry of a biomolecule and give a rational explanation of itsbiological reactivity based on stereochemistry.
- Understand the chemistry and biological functions of carbohydrates and lipids

SYLLABUS OF DSC-1

Unit I: Basic Concepts (6 hours)
Electronic displacements and their applications: Inductive, electromeric, resonance and hyperconjugation. Dipole moment, acidity and basicity. Types, shape and relative stability of carbocations, carbanions and free radicals. Electrophiles and nucleophiles, Intramolecular and intermolecular molecular forces including hydrophobic, hydrophilic interactions and hydrogen bond (emphasis on effect of these forces on the stability of biomolecules),

Unit II: Stereochemistry (8 hours)
Stereochemistry and its importance to biological systems, Stereoisomerism: Optical activityand optical isomerism, asymmetry, chirality, enantiomers, diastereomers. Mesomers, specificrotation; Resolution of racemic modification, Configuration and projection formulae: Newmann, Sawhorse, Fischer projections and their interconversion. Chirality in molecules with one and two stereocentres; CIP rules: Erythro/Threo, D/L andR/S designations.; Relative and absolute configuration; thalidomide case and chiral drugs; Geometrical isomerism: cis-trans, syn-anti and E/Z nomenclature.; Cis-trans isomerism in vision.

Unit III: Biologically significant chemical reactions (6 hours)
Aldol condensation (Glucogenesis), Retro-aldol (Glycolysis), Benzoin condensation (umpolung-decarboxylation of pyruvate in the presence of TPP), Claisen condensation (Synthesis of fatty acids), Michael addition (Dehydrases), Cannizzaro (Sugar metabolism), Baeyer Villiger reaction (FAD dependent ketone synthesis), Pinacole-pinacolone rearrangement (1,2-carbon carbon shift), Isomerisation(Glycolysis), Redox reaction(Lactate dehydrogenase).

Unit IV: Carbohydrates (6 hours)
Classification of carbohydrates, reducing and non-reducing sugars, biological functions, linkage between monosaccharides, general properties and reactions of glucose and fructose, their open chain structure, epimers, mutarotation and anomers, reactions of monosaccharides, configuration, cyclic structure (exclude structure elucidation) and Haworth projection formulae of glucose and fructose: structure of disaccharides (sucrose, maltose, lactose); polysaccharides- classification, structure of important members, storage polysaccharides (Glycogen, Starch) and structural polysaccharides (Cellulose, chitin, peptidoglycans and glycosaminoglycans)

Unit V: Lipids **(8 hours)**

Introduction, classification, biological importance of triglycerides, phospholipids, glycolipids, eicosanoids and steroids (cholesterol). Oils, Fats and Waxes: Common fatty acids present in oils and fats, essential fatty acids, characteristics of fatty acids and fats (saponification, iodine, acid, acetyl and peroxide values). Rancidity and reversion of fats; waxes, trans-fats and their biological significance.

Practical component: (60 hours)

1. Purification of organic compounds by recrystallization using the following solvents:
   i. Water
   ii. Water-Alcohol
   iii. Alcohol
2. Criterion of purity of organic compound- melting point, mixed melting point and boiling point of organic compounds.
3. Estimation of saponification value of fat/oil.
4. Estimation of iodine value of fat/oil.
5. Qualitative tests for carbohydrates and lipids
6. Chromatography

a) To separate a mixture of sugars by circular paper chromatography
b) To separate a mixture of lipids in a sample by Thin Layer Chromatography.

Essential/recommended readings

- A Guidebook to mechanism in organic chemistry (2003) 6 th ed., Sykes, P. New York: John Wiley & Sons. Inc
- Organic Chemistry (2014) 7 th ed., Morrison, R.T., Boyd, R.N., Bhattacharjee, S. K., Pearson Education
- Stereochemistry of Organic Compounds (1994), Eliel, E. L., Wilen, S. H. John Wiley& Sons.
- Stereochemistry: Conformation and Mechanism (2015) 8 th ed., Kalsi, P. S. New Age International
- Organic Chemistry (2013), Madan, R. L. Tata McGraw Hill Education PrivateLimited, New Delhi
- Organic Chemistry (2020) 8th Edn., Bruice, P. Y., Pearson

Suggestive readings: Nil

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 2: Photobiology

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code		Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (If any)
			Lecture	Tutorial	Practical/ Practice		
Photobiology	**DSC-102**		**2**	**0**	**2**	10+2 from any recognized Board with Biology & Candidates must appear in CUET in the following subject combination: **Physics+ Chemistry+ Biotechnology Biology/**	**Nil**

Learning Objectives

The Learning Objectives of this course are as follows:

- The course explores the physical properties of light and its interplay with living organisms. Light as a source of energy and information has shaped life on earth over the last 3.6 billion years. We see the world around us because the light reflected to the retina is processed to our brain (Photoreception), we breathe in oxygen because it has been evolved by the plants around us due to the light dependent Photosynthesis. Where there is no natural light, some organisms produce their own (Bioluminescence). Maintaining coordination with the changing light regime with changing seasons is fundamentally important to various aspects of living organisms across latitudes (Photoperiodism). Every part of the spectrum is used in one way or the other by different life forms. In this paper students will be able to appreciate the delicate processes of life that are dependent on light.

Learning outcomes

A student studying this course can:

- Understand and appreciate the dual nature of light.
- Comprehend the impact of light on biodiversity from pole to pole.
- Gain knowledge about the various photoreceptors in plants and animals and will appreciate and understand the mechanism of photosynthesis.
- Understand bioluminescence, photoperiodism and biological rhythms.
- Gain knowledge about the ecological and physiological responses to light.

SYLLABUS OF DSC-2

Unit 1: Introduction to Light and Life **(6 hours)**
Latitudinal Diversity gradient. Altitudinal and latitudinal variations in light intensity and photoperiod. Light as an ecological factor affecting distribution, physiological processes of plantsand animals (Phyto and Zoo geography), in terrestrial and aquatic ecosystems.

Unit 2: Bioluminescence and Photoreception **(6 hours)**
Discovery, diversity and functions of Bioluminescence. Comparative account of chemistry and functional roles of photoreceptors in plants: chlorophylls, carotenoids, phycobiliproteins, bacteriochlorophylls, etc. Photoreception in animals, evolution of eyes, color vision and visual processing in the human eye.

Unit 3: Photosynthesis **(6 hours)**

History, Spectrum of autotrophs, Photosynthetic equation, Photosynthetic electron transport (cyclic and non-cyclic), photolysis of water, oxygen-evolving complex (OEC), concept of Reaction centers, Q-cycle, Dark Reactions in Photosynthesis, C3, C4, CAM cycle, photorespiration (C2 cycle).

Unit 4: Photoperiodism **(6 hours)**

Phytochrome mediated responses in Plants, Animal responses to changing photoperiodism. Morphological, Anatomical, Physiological and behavioral adaptations to extreme light conditionsin plants and animals.

Unit 5: Ecological and physiological responses to Light **(6 hours)**

Morphological and physiological color change in animals. Light as an inducer for biosynthesis/activation of biomolecules (Vitamin D, Melatonin, Thymine dimer formation, RuBisCo. Three rythmn domains, Biological clocks and circadian rythmns, night shift disorders and jet lag.

Practical component: (60 hours)

1. To study light penetration in water using Secchi disc.
2. To demonstrate the effect of light on soil fauna using Berlese funnel setup.
3. To study the effect of light and darkness on the chromatophores of fish.
4. To test / survey for color blindness using Ishihara charts.
5. To study various Bioluminescent organisms using photographs- *Photinus pyralis, Aequorea victoria* , Vampire squid, Anglerfish, Lanternfish, Viperfish, Black dragonfish, *Omphalotus nidiformes*
6. Diel vertical migration using photographs
7. Measurement of light using Luxmeter under various conditions
8. To study structure of chloroplast- through photographs
9. Separation of Chloroplast pigments by Paper Chromatography/ Chemical Separation of

Chloroplast pigments
10. To study the effect of Light intensity and CO_2 concentration on the rate of Photosynthesis
11. Demonstration of Hill's Reaction and study the effect of Light intensity (any 2 light conditions).
12. Demonstration of Etiolation and de-etiolation.

Essential/ recommended Readings:

- Björn, L. O. (2015) 3rd Ed. *Photobiology: Science of Light and Life*, L.O. Bjorn.,Springer
- Buchanan, B. B., Gruissem, W., and Jones, R. L. (2000). *Biochemistry and molecular biology of plants*. Rockville, Md.: American Society of Plant Physiologists.
- Huner, N. and Hopkins, W. (2013). *Introduction to Plant Physiology*. In: 4th ed. John Wiley & Sons, Inc.
- Kohen E., Santus R., Hirschberg J.G. (1995) 1st Ed., *Photobiology* Academic Press
- Randall D., Burggren W., & French k. (2001) 5th Ed. *Eckert, Animal Physiology Mechanisms*
- *and Adaptations*. W.H. Freeman and Co.

Suggested Readings:

- Gross M. (2003). Light and Life. Oxford University Press
- Shimomura O., (2012) Bioluminescence: Chemical Principles and Methods, World Scientific,
- Taiz, L., & Zeiger, E. (1991). Plant physiology. Redwood City, Calif: Benjamin/Cummings Pub. Co.

Note: **Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.**

DISCIPLINE SPECIFIC CORE COURSE – 3: Diversity in lifeforms I

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Diversity in L ife forms I	**DSC-103**	**2**	**0**	**2**	10+2 from any recognized Board with Biology & Candidates must appear in CUET in the following subject combination: **Physics+ Chemistry+ Biotechnology Biology/**	**Nil**

Learning Objectives

The Learning Objectives of this course are as follows:

- The course will acquaint students with variations and variability in the living world and the objectives of biological classification. The course covers important aspects of biodiversity and its components with emphasis on understanding the features of Kingdom Animalia and Plantae and systematic organization of the same based on their evolutionary relationships. Studentswill also understand the importance of taxonomy and structural organization of animals from Protista to Echinodermata to appreciate the diversity of non-chordates living in varied habitats. They will study about the general characteristics and significance of Algae, Fungi, Bryophytes and Pteridophytes

Learning outcomes

After studying this course the student will be able to:

- Understand characteristic features of different plant and animal life forms.
- Identify, classify and differentiate diverse non-chordates based on their morphological, anatomical and systemic organization.
- Understand similarities and differences in life functions among various non-chordates.
- Appreciate and understand the relevance of wild relatives of cultivated plants, their domestication and green revolution.
- Understand the general characteristics, classification, economic importance, morphology, asexual and sexual reproduction of Algae, Fungi, Bryophytes and Pteridophytes

SYLLABUS OF DSC-3

Please provide weekly distribution

Unit I: Algae and Fungi **(6 hours)**

Importance of biodiversity in daily life. Biodiversity crisis and biodiversity loss,
Five kingdom classification and the position of Algae, Fungi, Bryophytes and Pteridophytes.
Algae: Study of general characteristics, Outline Classification, Economic Importance, Thallus Organization and Reproduction in Nostoc, Polysiphonia, Ectocarpus.
Fungi – General Characteristics, Outline Classification, Economic Importance, Thallus Organization and Reproduction in Rhizopus and Puccinia, Lichens (crustose, foliose and fruticose), Mycorrhiza (ectomycorrhiza and endomycorrhiza,VAM)

Unit II: Bryophytes and Pteridophytes **(8 hours)**

Bryophytes: General Characteristics; Outline Classification; Ecological and Economic Importance; Morphology, Structure and Reproduction (comparative) in *Marchantia* and *Anthoceros*
Pteridophytes: General Characteristics; Outline Classification; Economic Importance; Morphology, Structure and Reproduction in *Selaginella*

Unit III Introduction to Animal Life Forms **(6 hours)**

Introduction to animal diversity, Basic Taxonomy (Linnaean system of classification, Whittaker's five kingdom classification, ICZN Rules), General Characteristics of Non-Chordata and Chordata.

Unit IV: Non-Chordata Taxonomy and Diversity **(10 hours)**

Study of General Characteristics and Classification up to classes (Protista, Porifera, Cnidaria, Platyhelminthes, Aschelminthes, Annelida, Arthropoda, Mollusca, Echinodermata)

Practical component: (60 hours)

FLORA

1. Study of Vegetative and Reproductive Structures through Temporary Preparations and Permanent Slides- *Nostoc*, *Oedogonium*, *Polysiphonia; Chlamydomonas* (Through Photograph/Electron photomicrograph)
2. Study of Asexual Stage from Temporary/ Tease Mounts- *Rhizopus Albugo; Puccinia* - WM uredospores, teleutospores, Section of Leaf through pustules to show conidia
3. *Marchantia*-Morphology of Thallus, W.M. Rhizoids, V.S. Thallus through Gemma Cup, Antheridiophone (Permanent slide), Archegoniophore (Permanent Slide)), *Funaria*-Morphology of Gametophyte bearing Sporophyte, W.M. Rhizoids, W.M. Leaf, W.M. Operculum, W.M. Peristome, W.M. Spores (all Temporary Slides), L.S. Capsule (Permanent Slide).
4. *Selaginella*- Morphology, T.S. Stem, W.M. Strobilus, W.M. Microsporophyll and Megasporophyll (all Temporary Slides), L.S. Strobilus (Permanent Slide), *Pteris*-Morphology,
   V.S. Sporophyll, W.M. Sporangium, W.M. Spores (all Temporary Slides), W.M. Prothallus withSex Organs (Permanent Slide).

FAUNA

5. **Study of following specimens:** *Euglena, Paramecium, Sycon, , Tubipora,Taenia solium, Ascaris Phertima, Hirudanaria, Peripatus, Scolopendra, Julus, Cancer, Daphnia, Apis, Pila,Dentalium, Octopus, Asterias*
6. **Dissections / Virtual demonstration:** Nervous system of Cockroach, Salivary apparatus andOvary of Cockroach.
7. Study of adult *Fasciola hepatica*, *Taenia solium* and their life stages (Slides/micro-
   photographs).
8. Study of following permanent Slides.

a. T.S. and L.S. of *Sycon*.
b. Crustacean larvae (W.M. Mysis, W.M. Megalopa, W.M. Zoaea).

9. To study faunal composition of water samples (Lucky drop method).
10. Field trip on: Biodiversity park/reserve/ NBPGR. (Botany + Zoology)

Essential/ recommended readings:

- Barnes, R.D. (1982). *Invertebrate Zoology*, 5th. Edition
- Campbell N. A., (2008).*Biology* 8th Edition, Pearson
- Barrington, E.J.W. (2012). Invertebrate Structure and Functions. II Edition, EWP Publishers
- Singh, V. (2010). *A text book of botany*. Rastogi Publications.
- Ennos, R., & Sheffield, E., (2000). *Plant Life*. UK: University Press, Cambridge.

Suggested readings:

- Ingrowille, M., (1992).*Diversity and Evolution of land plants*. Chapman and Hall
- Wilson, E. O., (1998). *Biodiversity*.National Academic Press.
- Barnes, R.D. (2006). Invertebrate Zoology, VII Edition, Cengage Learning, India.

Note: **Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.**

DEPARTMENT OF ANTHROPOLOGY

BSc (Hons.) Anthropology
Category-I

DISCIPLINE SPECIFIC CORE COURSE – 1: Introduction to Biological Anthropology

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course t itle & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite o f the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Introduction to Biological Anthropology	4	3	0	1	Class X II pass with biology	NIL

Learning Objectives

The Learning Objectives of this course are as follows:
1. In order to acquaint the students with the fundamental concepts of Biological Anthropology
2. To introduce the student a foundational understanding of human variation and evolution of human and non-human primates

Learning outcomes

The Learning Outcomes of this course are as follows:
1. The students will comprehensively learn the scope and focal theme of biological anthropology along with its implications.
2. They will also learn the emergence of mankind in the context of human evolution and variation.
3. Further, this paper will help them in learning the role of evolutionary forces in bio-cultural human adaptations in the context of changing environment.

SYLLABUS OF DSC-1

UNIT – I History, Concepts, Aims and Scope (9 hours)
1. History and development of Biological Anthropology
2. Basic concepts of human evolution and variation
3. Scope and relationship of biological anthropology with other disciplines

UNIT – II Theories of Evolution (12 hours)
1. Pre-Darwinian Theories of Evolution
2. Darwinism and Synthetic theory of evolution

UNIT – III The primates (12 hours)
1. Classification and characteristics of living primates, Primate radiation

2. Primate Locomotion, Comparative anatomy and behaviour of human and non-human primates
3. Significance of non-human primate study in biological anthropology

UNIT – IV Human Variation and Concept of Race (12 hours)
1. Traditional and modern methods of studying human variation
2. Racial Classification of Mankind
3. Indian Racial classifications: Risley, Guha and Sarkar
4. UNESCO statement on Race and Current understanding of Race

Practical component (if any) - (30 hours)

Somatometry
1. Height/ Stature; Sitting height; Body weight
2. Maximum Head Length; Maximum Head Breadth; Minimum Frontal Breadth; Maximum Bizygomatic Breadth; Bigonial Breadth; Head Circumference
3. Physiognomic Facial Height; Morphological Facial Height; Physiognomic Upper Facial Height; Morphological Upper Facial Height
4. Nasal Height; Nasal Length; Nasal Breadth; Cephalic Index; Nasal Index

Somatoscopy
1. Head form; Facial form; Nose form; Eye form; Hair form
2. Skin colour; Hair Colour; Eye Colour

Essential/recommended readings

1. Campbell, G. (2016). The Ethnology of India. Wentworth Press.
2. Ember, C, R., Ember, M. Peregrine, P.N (2015). Anthropology (Twelfth Edition). Pearson Education Inc. Boston, USA [Unit-1: Chapter-1 and 2; Unit-2; Chapter -3 and 4; Unit-3: Chapter-5 and 6]
3. Eugenia Shanklin (1993). Anthropology and Race: The Explanation of Differences. Cengage Learning: 1 edition [Unit-4].
4. Jurmain R., Kilogre L., Trevathan W., Ciochon R.L. (2012). Introduction to Physical Anthropology. Wadsworth Publications, USA. [Unit-1: Page-3-23; Unit-2: Page 25-113; Unit-3: Page-143-225].
5. Statement of Race: Annotated Elaboration and Exposition of the Four Statements on Race (1972). Issued by UNESCO. Oxford University Press. 14.
6. Trudy R. Turner (2005). Biological Anthropology and Ethics: From Repatriation of Genetic Identity. State University of New York Press [Unit-3; Page 27-64].
7. Winfried Henke and Ian Tattersall (Eds.) (2007). Handbook of Paleoanthropology (Volume II). Springer.
8. Winfried Henke and Ian Tattersall (Eds.) (2007). Handbook of Paleoanthropology (Volume III). Springer

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 2:
Society and Culture: Concepts and Approaches

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Society and Culture: Concepts and Approaches	**4**	**3**	**0**	**1**	Class XII pass with biology	**NIL**

Learning Objectives

The Learning Objectives of this course are as follows:
1. The course introduces concepts of Society and Culture and their role in shaping human lives
2. Raises awareness about ethnocentrism and cultural relativism
3. Outlines some basic concepts and approaches to social and cultural changes

Learning outcomes

The Learning Outcomes of this course are as follows:
The students will be able to:
1. Critically interrogate who we are and what we do.
2. Understand the basic concepts and methods of social and cultural Anthropology.
3. Understand how social and cultural differences operate in the world.

SYLLABUS OF DSC-2

UNIT – I Concept of Society (12 hours)
Concept of Society, Status and Role, Group, Association, Community and Institutions Social Fact, Social Action, Social Conflict

UNIT – II Concept of Culture (12 hours)
Culture and its attributes, Enculturation, Ethnocentrism, Cultural Relativism, Paradoxes of Culture, Cultural Change, Culture Trait, Culture Complex, Culture Area Tangible and Intangible Culture

UNIT – III Emergence and Historical Development of Social Anthropology (12 hours)
Early writings: Colonial accounts of travelers and administrators; Ethnography, Ethnology and Social Anthropology; Scope and Relevance; Relationship with other disciplines.

UNIT – IV Approaches to Culture and Society (9 hours)
Evolutionism, Diffusionism, and Historical Particularism

Practical component (if any) – (30 hours)
Research projects based on everyday life experiences from different walks of life in different cultures. Students will be required to operationalize various concepts, identify the variables and examine their relationships in small field settings.

Essential/recommended readings

1. De Annemarie Waal Malefijt (1916) Images of Man: A History of Anthropological Thought. Random House.
2. Barnard, A. (2021). History and theory in anthropology (Second Edition). Cambridge: Cambridge University Press (Selected Chapters).
3. Davis, K. (1973). Human society. New York: Macmillan. (Page: 289-391).
4. Durkheim, E. (2013). The Rules of Sociological Method and Selected Texts on Sociology and its Method Edited by Steven Lukes (Second Edition). Houndmills: Palgrave Macmillan. (Page: 20-49, 78-100).
5. Eriksen, T. H. (2015). Small Places, Large Issues: An Introduction to Social and Cultural Anthropology (Fourth Edition). London: Pluto Press (Selected Chapters).
6. Gluckman, M. (1956). Custom and Conflict in Africa. Oxford: Basil Blackwell. (Page: 1-26, 27-53).
7. Marx, K. and F. Engels. (2008). The Communist Manifesto (with an introduction by David Harvey). London: Pluto. (Page: 31-82)
8. Michael Wesch. 2018. The Art of Being Human (First Edition). Manhattan, Kansas: New Prairie (Whole book).
9. Linton R (1936) Study of Man; Manchester: D Appleton-Century.
10. Rapport N. and Overing J. (2004). Key Concepts in Social and Cultural Anthropology. London: Routledge. (Page: 333-343, 92-102).

Note: **Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.**

DISCIPLINE SPECIFIC CORE COURSE – 3: Introduction to Archaeological Anthropology

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Introduction to Archaeological Anthropology	**4**	**3**	**0**	**1**	Class XII pass with biology	**NIL**

Learning Objectives

The Learning Objectives of this course are as follows:
1. The course will enhance students understanding of human prehistory in the light of human origins.
2. The course will help students to develop concepts pertaining to the fundamentals of archaeological anthropology

Learning outcomes

The Learning Outcomes of this course are as follows:

Students will learn on evolutionary relationships of different extinct/hominids in the context of emergence of various stone tool types and settlements.

SYLLABUS OF DSC-3

UNIT – I Introduction (9 hours)
1. Definition and scope of archaeological anthropology
2. Relation with other disciplines
3. Methods of studying archaeological anthropology

UNIT – II Methods of Estimation of Time and Reconstruction of the Past **(12 hours)**
1. Absolute dating methods
2. Relative dating methods
3. Geochronology of Pleistocene Epoch
4. Glacial and Interglacial
5. Pluviation and Inter Pluviation
6. Different types of geoclimatic events.

UNIT – III Understanding Culture **(12 hours)**
1. Technique of tool manufacture and estimation of their relative efficiency
2. Classification of tools: primary and combination fabrication techniques
3. Typology and cultural nomenclature

UNIT – IV Earliest Evidence of Culture in the World **(12 hours)**

Konso, Olorgesailie, Olduvai Gorge, Pirro Nord, Dmanisi, Attirampakkam, Isampur

Practical component (if any) (30 hours)
Typo-technological Analysis of Prehistoric Tools: Identification, Interpretation and Drawings of the tool Types
1. Core Tool Types
2. Flake Tool Types
3. Blade Tool Types

Essential/recommended readings

1. Renfrew Colin and Bahn Paul (2012) Archaeology: Theories, Methods and Practice. New York: Thames & Hudson, 6th Edition.

2. Fagan Brian M. and Nadia Durrani (2014). In the Beginning: An Introduction to Archaeology, London: Routledge, 14th Edition.
3. Champion Timothy, Clive Gamble, Stephen Shenan & Alasdair Whittle (2009) Prehistoric Europe, London: Routledge
4. Allchin, Bridget and Allchin, Raymond F. (2003) The Rise of Civilization in India and Pakistan. Cambridge: Cambridge University Press.
5. Phillipson D. W. (2005). African Archaeology. Cambridge: Cambridge University Press.
6. Whittaker, J.C. (2009) Flintknapping: Making and Understanding Stone Tools. Austin: University of Texas Press.
7. Odell, George H. (2003). Lithic Analysis. New York: Springer.
8. Moloney and Shott, M.J. (2016). Lithic Analysis at the Millennium, New York: Routledge.
9. Bhattacharya, D.K: An outline of Indian Prehistory (2006) Palaka prakashan Delhi
10. Bhattacharya, D.K. (1979). Old Stone Age Tools: A Manual of Laboratory Techniques of Analysis. Calcutta: K. P. Bagchi and Company.
11. Inizan, M.L.; M. R. Ballinger; H. Roche and J. Tixier. (1999). Technology and terminology of Knapped Stone. Nanterre: CREP.
12. Oakley, K.P. (1972). Man the Tool Maker. London. Trustees of the British Museum Natural History.
13. Sankalia, H.D. (1982). Stone Age Tools: Their techniques, Names and Probable Functions. Poona: Deccan College.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

COMMON POOL OF GENERIC ELECTIVE COURSES
OFFERED BY DEPARTMENT OF ANTHROPOLOGY

Category-IV

GENERIC ELECTIVES (GE-1)

Credit distribution, Eligibility and Pre-requisites of the Course

Course t itle & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Forensic and Criminal investigations	4	3	0	1	Class X II pass with biology	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- Give exposure of Forensic Science to students which focus on the investigation process of a crime.
- Enhance understanding of forensic applications and criminal investigations by teaching and research.
- Develop skills in forensic identification and problem solving methods.
- Keep up to date knowledge about all recent developments and emerging trends in Forensic science and criminal investigation.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand the aim, concept and significance of Forensic Science and Criminal Investigation.
- To make aware about recent techniques and developments of Forensic Science and Criminal Investigation.

SYLLABUS OF GE-1

UNIT – I: Forensic Science, Crime Scene Management and criminal investigation **(9 hours)**

- Introduction, history, development, laws and branches of Forensic Science.
- Organizational set-up of Forensic science laboratories.
- Crime scene protection, isolation, documentation, sketching, field notes and photography.
- Definition, concept, types and scope of crime, various control and prevention methods of crime.
- Criminology, criminal anthropology and criminal law

UNIT – II Forensic Ballistics and Explosives (9 hours)

- History, background, classification and characteristics of Firearms
- Internal, External, Terminal (wound) ballistics

- Classification, synthesis and characteristics of explosives.
- Examination and identification of firearms and explosives evidences.

UNIT – III Forensic Chemistry and toxicology (9 hours)

- Introduction, sampling, presumptive, screening and analytical techniques in Forensic Chemistry.
- Definition, classification and extraction of poisons.
- Toxicological techniques used in poisoning cases.
- Classification of drugs, Field and laboratory tests of drugs of abuse.

UNIT – IV Questioned Documents and fingerprint examination (9 hours)

- Classification of forensic documents, importance of natural variation and disguised writing
- Class and individual characteristics of handwriting and documents examination.
- History and classification of fingerprints, Conventional and modern methods of developing latent fingerprint.
- Automated Fingerprint Identification System (AFIS).

UNIT – V Forensic anthropology, Serology and DNA profiling (9 hours)

- Personal identification of living and non- living individual through various anthropological techniques.
- Forensic morphometric techniques of skeleton remains, Human and non-human identification.
- Sex determination, stature and age estimation from skeleton remains
- History, biochemistry and genetics of ABO, Rh, MN and other blood systems. Blood pattern analysis and blood stains ageing.
- DNA profiling and its application in criminal and civil investigations.

Practical component (if any) -

1. Descriptive study of organizational structure of a forensic science laboratory.
2. Interpretation of crime scene notes, photos, sketches, crime scene reconstruction and mock crime scene investigation.
3. Linkage of suspected bullet and cartridge case with the class and individual characteristics of firearms.
4. TLC and spot test for different toxic and drugs substances
5. Forensic identification of class and individual characteristics of handwriting
6. Examination of passports and currency notes
7. Various powder and chemical methods used for latent fingerprints.
8. Ridge characteristics, counting, and fingerprint comparison
9. Morphometric examination of skeleton remains
10. Sex determination, age and stature estimation from skeleton remains.
11. Examination of blood groups from fresh and dried blood stains
12. Preliminary and confirmatory tests for blood stains.

Essential/recommended readings

1. Sharma, B.R; Forensic Science in Criminal Investigation & Trials, Universal Publishing Co., New Delhi, 2003
2. Saferstein; Criminalistics- An Introduction of Forensic Science, Prentice Hall Inc, USA,2007.
3. Swansson, C.R, Chamelin, N.C, &Territ, L; Criminal Investigator, McGrawhill, New York, 2000.
4. The Indian Evidence Act,(1872), Amendment Act (2002); Universal Law Publishing Co., 2003.
5. The Code of Criminal Procedure (1973) Amendment Act, (2001); Universal Law Publishing Co., 2002.
6. Rattan Lal &DhirajLal; The Indian Penal Code, 28th Ed. Wadhwa& Co. Nagpur, 2002.
7. Clark E.G.C; Isolation and Identification of drugs, Academic Press, London, 1986
8. Feigl, F; Spot Test in Inorganic Analysis, Elsevier Publ. New Delhi, 2002
9. Sharma, B.R.; Firearms in Criminal Investigation & Trials, 4th Ed, Universal Law Publishing Co Pvt Ltd, New Delhi, 2011.
10. Hilton, O; Scientific Examination of Questioned Documents. Revised Edition, Elsevier, New York, 1982.
11. Singh, I.P. & Bhasin M.K; A manual of biological Anthropology, Kamla Raj Enterprises, New Delhi, 2004.
12. Eveleth, P.B. & Tanner, J.M; Worldwide Variation in Human Growth, Cambridge University Press, London, 1976.
13. Seigel, J.A, Sukoo, R.J, &Knupfer, G.L; Encyclopaedia of Forensic Science, Academic Press, London, 2000.
14. Pickering, R. & Bachman D; The use of Forensic Anthropology, CRC Press, Costa Rica, 2009.
15. Butler, J; Advanced Topics in Forensic DNA Typing: Methodology, 1st Ed., Academic Press, London, 2009.
16. Cummins, H., &Midlo, C. (1961). Finger Prints, Palms and Soles. New York: Dover Publications.

GENERIC ELECTIVES (GE-2)

Credit distribution, Eligibility and Pre-requisites of the Course

Course t itle & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Anthropology of Sustainable Development	**4**	**3**	**0**	**1**	**Class X II pass with biology**	**NIL**

Learning Objectives

The Learning Objectives of this course are as follows:
The objective of the paper is to understand the discourse around the idea of sustainable environment along with relevant issues and emerging challenges in managing the planetary crisis and the problems due to environmental degradations.

Learning outcomes

The Learning Outcomes of this course are as follows:
By studying the paper, the students will be able to:
• Understand the nature and scope of sustainable development, basic concepts in it.
• Know the importance of traditional ecological knowledge in sustainable development
• Contemporary issues and challenges in sustainable development and environmental degradation, biodiversity and conservation.

SYLLABUS OF GE-2

UNIT – I (9 hours)
Notion of Sustainable Development Genesis and Approaches; Economy, Equity and Environment: Idea of Triple Bottom-line
UNIT – II (12 hours)
United Nation's Sustainable Development Goals, Interconnections and Integration,
Cultural diversity and Execution of SDG: Ethnographic Cases, Frameworks of Assessment
UNIT – III (12 hours)
Issues of planetary Crisis and idea of sustainable livelihood, Alternative and Sustainable use of natural resources: water, energy, mines and materials
UNIT – IV (12 hours)
Environmental Issue: Biodiversity, Indigenous Knowledge, Traditional Practices associated with sustainable nature

Practical component (if any) - (30 hours)
I. Prepare an evaluative study/ a project based on any contemporary issue in India by employing various sources viz. books, journals, magazines, government reports newspaper articles, etc.
2. Presentation of the project and group discussion

Essential/recommended readings

1. Brightman, Marc. and Lewis, Jerome. (2021).Anthropology of Sustainability: Beyond development and progress. Palgrave Macmillan
2. Carroll, Bryce. (2017). An Introduction to Sustainable Development. Larsen & Keller Education.
3. Corsi, Patrick. (2017). Going Past Limits to Growth: A Report to the Club of Rome EU-Chapter. John Willey & Sons Inc.
4. Elliott, Jennifer A. (2013). An introduction to sustainable development. New York: Routledge.
5. Eversole, Robyn. (2018). Anthropology for Development: From Theory to Practice. Routledge.

6. Meadows, Donella H; Meadows, Dennis L; Randers, Jorgen; and William, W. Behrens III. (1972). The Limits to growth: A report for the Club of Rome's project on the predicament of mankind. New York: Universe Books.
7. Sachs, Jeffrey. D. (2015). The age of sustainable development. New York. Columbia University Press

GENERIC ELECTIVES (GE-3)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Biodiversity and indigenous Knowledge	**4**	**3**	**0**	**1**	**Class XII pass with biology**	**NIL**

Learning Objectives

The Learning Objectives of this course are as follows:
The course will help the students in understanding how indigenous knowledge and biodiversity are complementary phenomena essential to human development. Students will recognize indigenous knowledge as an important national resource and understand the collective knowledge of biodiversity and its use

Learning outcomes

The Learning Outcomes of this course are as follows:
I. Students will learn basic concepts of biodiversity and indigenous knowledge along with the rich traditional resources in management and conservation of biological diversity.
2. The course will help students to understand concepts pertaining to conservation of biodiversity and protection of indigenous knowledge including the indigenous management strategies of farmers.
3. They will also learn policies and laws relating to biodiversity conservation including protection of intellectual property rights relating to indigenous knowledge.

SYLLABUS OF GE-3

UNIT – I (9 hours)
Biodiversity: basic concept, UN Convention on biodiversity, health implications of biological diversity; conservation of biological diversity- policies and law.

UNIT – II (12 hours)
Human-animal interface- interface between human and animal world; Zoonotic diseases types, etiology and prevention, biodiversity and genetic resources.

UNIT – III (12 hours)
Indigenous Knowledge: basic concept, critique of western scientific knowledge, historical context of the emergence of indigenous knowledge, contemporary relevance of indigenous knowledge, indigenous knowledge in biodiversity conservation.

UNIT – IV (12 hours)
Problems of Indigenous Knowledge: issues pertaining to transfer of indigenous knowledge, debates for making indigenous knowledge universal, politics of indigenous knowledge, notion of identity and property; Intellectual Property Rights related to biodiversity and indigenous knowledge, protection of plant varieties.

Practical component (if any) -

Project Report on Indian Cases pertaining to Indigenous Knowledge, Intellectual Property Rights and Biodiversity

Essential/recommended readings

1. Antweiler, C. (2004). Local Knowledge Theory and Methods: An Urban Model from Indonesia. *In Investigating Local Knowledge: New Directions, New Approaches* (eds.) Alan Bicker, Paul Sillitoe& John Pottier. Ashgate. 1-34
2. Ellen, R. (2003). Variation and Uniformity in the Construction of Biological Knowledge across Cultures. In *Nature Across Cultures: Views of Nature and Environment I Non Western Cultures* (eds.) H. Selin, Great Britain: Kluwer Academic Press.
3. Eldredge, N. (2002). What Is Biodiversity? In *Life on Earth: An Encyclopedia of Biodiversity, Ecology, and EvolutionVolume 1 A–G*. ABC-CLIO, Inc. Santa Barbara, California. 1-30
4. Gadgil, M., Berkes, F &Folke, C. (1993). Indigenous Knowledge for Biodiversity Conservation. AMBIO, Springer, 22 (2/3): 152-156
5. Leveque, C. &Mounolou, J. (2003). Brief History of a Concept: Why be concerned by Biological Diversity? In *Biodiversity*. John Wiley & Sons Ltd. 5-12
6. Leveque, C. &Mounolou, J. (2003). The Dynamics of Biological Diversity and the Consequences of Human Activities. In *Biodiversity*. John Wiley & Sons Ltd. 131-164
7. Leveque, C. &Mounolou, J. (2003). The Dynamics of Biological Diversity and Implications for Human Health. In *Biodiversity*. John Wiley & Sons Ltd. 165-184
8. Leveque, C. &Mounolou, J. (2003). Genetic Resources and Biotechnology. In *Biodiversity*. John Wiley & Sons Ltd. 185-206
9. Leveque, C. &Mounolou, J. (2003). The Conservation of Biodiversity. In *Biodiversity*. John Wiley & Sons Ltd. 225-248
10. Mandal, M. (2009). Internal Displacement in India: Status, Condition & Prospects of Return. *Refugee Watch*, 33: 33-47
11. Marselle, M. R. (2021). Pathways linking biodiversity to human health: A conceptual framework. *Environment International, Elsevier.* 150: 106420
12. Murray Li, T. (2007). Articulating Indigenous Identity in Indonesia: Resource Politics and Tribal Slot. In *Environmental Anthropology: A Historical Reader* (eds.) Michael Dove & Carol Carpenter. Blackwell.

13. Palsson, G. (2007). Bio-value: Appropriating Genomes. In *Anthropology and the New Genetics*. Cambridge University Press.
14. Posey, D. (2008). Indigenous Management of Tropical Forest Ecosystem: The Case of the Kayapo Indians of the Brazilian Amazon. In *Environmental Anthropology: A Historical Reader* (eds.) Michael Dove & Carol Carpenter. Blackwell.
15. Sillitoe, P. (1988). The Development of Indigenous knowledge: A New Applied Anthropology. *Current Anthropology* 19 (2):
16. United Nations, (1992). Convention on Biological Diversity (1992). 1-17
17. Wadehra, B.L. (2012). Protection of Plant Varieties and Farmers' Rights. In *Law Relating to Intellectual Property***5** (eds.) Universal Law Publishing Co. New Delhi. 517-528
18. Vayda, A. P., Walters, B.B. &Setyawati, I. (2004). Doing and Knowing: Questions about Studies of Local Knowledge. In *Investigating Local Knowledge: New Directions, New Approaches* (eds.) Alan Bicker, Paul Sillitoe& John Pottier. Ashgate. 35-58

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVES (GE-4)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Health Systems, Promotion and Management	4	3	0	1	Class XII pass with biology	NIL

Learning Objectives

The Learning Objectives of this course are as follows:
1. To understand basic idea of health systems, health promotion
2. To assess the health care management strategies
3. To understand the public health value of health promotion in different health systems

Learning outcomes

The Learning Outcomes of this course are as follows:
The students will learn the basic concepts of health system research, creatively design health promotion strategies and understand various challenges of health care management.

SYLLABUS OF GE-4

UNIT – I (9 hours)

Introduction to the basic concepts of health systems, health promotions and health management

UNIT – II (12 hours)
Models, Contexts and Agents of health promotion; practice framework of health promotion: lifestyle, diet, and physical activity

UNIT – III (12 hours)
Health system of (India vs International), health system framework: private and state functioning, health system spending and financing

UNIT – IV (12 hours)
Health care institutes/centre management: health care resource, clinical and technological challenges, cost containment, hospital waste management, health care emergency management

Practical component (if any) -

Project report based on activity related health promotion, or data collection related to health systems or management

Essential/recommended readings

Josep Figueras, Martin McKee, Jennifer Cain&; Suszy Lessof. Health Systems in Transition: Learning from Experience. World Health Organization, 2003.

- Bruce R. Schatz, Richard B. Berlin Jr. (auth.). Healthcare Infrastructure: Health Systems for Individuals and Populations [led.]. Springer-Verlag London, 2011
- Pruss, E. Giroult, Philip Rushbrook. Safe management of wastes from health-care activities. World Health Organization, 1999

Michael J. Reilly, David S. Markenson. Health Care Emergency Management: Principles and Practice [1 ed.], 2010

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVES (GE-5)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Anthropology and Fieldwork	4	3	0	1	Class XII pass with biology	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

The objective of the course is to introduce the students to the technique of fieldwork, a highly sophisticated qualitative research method developed in the discipline over a century. The students shall learn the innovative ways of designing and doing fieldwork in different anthropological settings.

Learning outcomes

The Learning Outcomes of this course are as follows:
The students will learn how to design and undertake fieldwork using anthropological tools of research. They will also learn the intellectual trajectory of the field work tradition affecting various disciplines.

SYLLABUS OF GE-5

UNIT – I Fieldwork Tradition in Anthropology **(9 hours)**
The Beginning: Reports of travellers, administrators and missionaries Invention of the 'non-western others' and the colonial agenda

UNIT – II Designing Field Research **(12 hours)**
Conceiving the universe of study
Identifying techniques of data collection
Pre-testing and Pilot study
Community immersion and researchers' identity

UNIT – III The Changing notion of Anthropological Field **(12 hours)**
Anthropological field in the era of globalisation Mobility and interconnection: multi-sited ethnography

UNIT – IV Data Analysis and Report Writing **(12 hours)**
Qualitative and thematic analysis, content analysis
Analysis of metaphors and narratives
Language of representation and persuasion

Practical component (if any) – (30 hours)
The students shall prepare a project report using fieldwork as a method of data collection.
Practical exercises will include task such as identification of units and universal study, designing tools of field research and to pre-test it for ensuring reliability and validity.

Essential/recommended readings

Madan & Beteille. (1975). Encounter and Experience: Personal Accounts of Fieldwork. University Press of Hawaii.
• Brewer, D. John. (2000). Ethnography. McGraw Hill Companies.
•Malinowski, B. (1922). Agronauts of Western Pacific: An Account of Native Enterprise and Adventure in the Archipelagoes of Melanesian New Guinea. London: Routledge & Kegan Paul Ltd.
• Okley, J. (2012). Anthropological Practice: Fieldwork and Ethnographic Method. Routledge.
• Spradley, J.P. (2016). Participant observation. Waveland Press.
• Evans- Pritchard, E.E. (1994). Social Anthropology. New Delhi: Universal Book Stall

- Srivastava, V. K. Edited (2005). Methodology and Fieldwork. New Delhi: Qxford University Press.
- Patnaik, S. M. (2011). Culture. Identity and Development: An Account of Team Ethnography among the Bhil of Jhabau. Jaipur: Rawat Publications.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVES (GE-6)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Genetic Research in Anthropology	**4**	**3**	**0**	**1**	**Class XII pass with biology**	**NIL**

Learning Objectives

The Learning Objectives of this course are as follows:
1. To introduce human genetics through anthropological perspectives where impetus will be laid on building an understanding of biochemical and molecular markers and their relevance in anthropology.
2. The course focuses on application of anthropological genetics in mendelian populations and molecular basis of complex diseases.
3. The course also focuses on aspects of field work, data collection, ethical, legal and social issues in genetic research in anthropology.

Learning outcomes

The Learning Outcomes of this course are as follows:
1. The students will be trained to use biochemical markers with respect to disease profile.
2. The students can be better equipped to understand the importance of mendelian populations in genetic research that can be applied to disease genetics.
3. The students will be skilled with basic laboratory techniques for molecular markers.
4. The students will be better equipped to comprehend fieldwork and data collection along with an understanding of ethical and legal aspects of genetic research.

SYLLABUS OF GE-6

UNIT – I Basic concepts (9 hours)

History and relevance of genetic research in anthropology, evolution of genetic markers as a tool in human research, concept of Hardy-Weinberg Equilibrium principle.

UNIT – II Methods of genetic research in anthropology (9 hours)

Twin studies, genetic linkage studies, pedigree analysis, candidate gene studies, cohort studies, cross-sectional studies, hypothesis and technology driven research

UNIT – III Data collection in human genetic studies (9 hours)

Field work and data collection strategies, quantitative and qualitative data collection in field

UNIT – IV Techniques in human genetics (9 hours)

Agglutination, electrophoresis, PCR, sequencing techniques

Unit-V: Ethical, legal and social issues in genetic research (9 hours)

Ethical guidelines and practices in genetic research, legal and social issues in genetic research, Indian national guidelines for collaborative research in genetics.

Practical component (if any) - (30 hours)

1. ABO blood group
2. DNA extraction
3. Identification of genetic mutation through specific technique

Essential/recommended readings

1. Speicher, M. R., Motulsky, A. G., &Antonarakis, S. E. (Eds.). (2010). Vogel and Motulsky's human genetics. Berlin, Heidelberg: Springer Berlin Heidelberg.
2. Crawford, M. H. (Ed.). (2007). Anthropological genetics: theory, methods and applications. Cambridge University Press.
3. Mange, E. J., & Mange, A. P. (1999). Basic human genetics. Sinauer Associates Inc.,U.S.
4. Reich, D., Thangaraj, K., Patterson, N., Price, A. L., & Singh, L. (2009). Reconstructing Indian population history. Nature, 461(7263), 489-494.
5. DePristo, M. A. (2010). The $1,000 genome: The revolution in DNA sequencing and the new era of personalized medicine. The American Journal of Human Genetics, 87(6), 742.
6. Jaworski, E., Routh, A., Head, S. R., Ordoukhanian, P., & Salomon, D. R. (2018). Next Generation Sequencing: Methods and Protocols. Springer New York.
7. Indian Council of Medical Research. (2017). National ethical guidelines for biomedical and health research involving human participants. National Ethics Guidelines for Biomedical and Health Research involving Human Participants.
8. Kumar, M., Sandhu, H., & Roshan, R. (2020). Indian Council of Medical Research's International Collaboration & Partnerships; Health Ministry's Screening Committee: Facts, figures & procedures. The Indian Journal of Medical Research, 151(6), 550.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DEPARTMENT OF ENVIRONMENTAL SCIENCE

B.Sc. (H) ENVIRONMENTAL SCIENCE
Category-I

DISCIPLINE SPECIFIC CORE COURSE – 1: ENVIRONMENTAL AND EARTH SURFACE PROCESSES

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
ENVIRONMENTAL AND EARTH SURFACE PROCESSES	4	2	0	2	Class XII pass	NIL

Learning Objectives

•Introduce students to the basic structure and composition of the Earth
•Explore various surface processes and their impact on and role in living systems
•Analyse interactive processes in the inner as well as outer Earth's surface

Learning outcomes

After this course, students will be able to learn the following skills.
•Acquire environmental field mapping skills to identify rocks, landforms, soils, and minerals
•Analyse surface and near-surface processes and products;
•Develop the current status of earth's processes while correlating it with global changes through time.
•Correlate landform and environmental conditions based on the evolution of the earth
•Relate and interpret the geological history of an area based on rock analyses
•Use satellite data to interpret Earth's geology or landscape

SYLLABUS OF DSC-1

UNIT – I HISTORY OF EARTH (6 hours)
Solar system formation and planetary differentiation; formation of the Earth: formation and composition of core, mantle, crust, atmosphere and hydrosphere; Geological time scale and major changes on the Earth's surface; Holocene and the emergence of humans, role of humans in shaping landscapes; development of cultural landscapes.

UNIT – II EARTH SYSTEM PROCESS (8 hours)
Movement of lithosphere plates; mantle convection and plate tectonics, major plates and hot spots; sea floor spread; earthquakes; volcanic activities; orogeny; isostasy; gravitational and

magnetic fields of the earth; continental drift and present-day continents, paleontological evidences of plate tectonics; continental collision and formation of the Himalaya and mountains.

UNIT – III MINERALS AND ROCKS (8 hours)

Minerals and important rock forming minerals; rock cycle: lithification and metamorphism; Three rock laws; rock structure, igneous, sedimentary and metamorphic rocks; weathering: physical, biogeochemical processes; erosion: factors and agents of erosion; rivers and streams, glacial and aeolian transportation and deposition of sediments by running water, wind and glaciers

UNIT IV– EARTH SURFACE PROCESSES (8 hours)

Atmosphere: evolution of earth's atmosphere, composition of atmosphere, physical and optical properties, circulation; interfaces: atmosphere–ocean interface, atmosphere land interface, ocean–land interface; land surface processes: fluvial and glacial processes, rivers and geomorphology; types of glaciers, glacier dynamics, erosional and depositional processes and glaciated landscapes; coastal processes

Unit V: IMPORTANCE OF BEING A MOUNTAIN (8 hours)

Formation of Peninsular Indian Mountain systems - Western and Eastern Ghats, Vindhyas, Aravallis, etc. Formation of the Himalaya; development of glaciers, perennial river systems and evolution of monsoon in Indian subcontinent; formation of Indo-Gangetic Plains, arrival of humans; evolution of Indus Valley civilization; progression of agriculture in the Indian subcontinent in Holocene.

Practical component (if any) - (60 hours)

1. Field survey and learning what and how are to be collected, observed, and recorded as a young field environmental geologist.
2. Field visit to identify natural agents derived landform and geomorphic features.
3. Field surveys and learning indicators of geomorphology, external features, texture, colour, mineral composition, and minerals to identify the rock types
4. Mapping of igneous, sedimentary, and metamorphic rocks and drawing sketches to highlight important features of different rock types
5. Megascopic identification of mineral samples: bauxite, calcite, chalcopyrite, feldspar, galena, gypsum, hematite, magnetite, mica, quartz, talc, tourmaline;
6. Estimate the relative density of soil and conduct sedimentation analysis using hydrometer method.
7. Determine plastic limit of soil and determine soil permeability
8. Study any glacier, its flow direction, identification of glacial erosional and depositional landforms, and analysis.
9. Read, prepare and interpret geological maps to analyze petrographical and structural features.
10. Read and interpret topographical maps, aerial photographs, satellite imagery, and digital elevation models for the earth's surface features
11. Locate the epicenter of an earthquake
12. Interpret earth's history using igneous and sedimentary rock

Suggestive readings

- Bridge, J., & Demicco, R. 2008. Earth Surface Processes, Landforms and Sediment Deposits. Cambridge University Press.
- Cronin, V.S., 2018. Laboratory Manual in Physical Geology. Pearson.
- Keller, E.A. 2011. Introduction to Environmental Geology (5th edition). Pearson Prentice Hall.
- Leeder, M., Arlucea, M.P. 2005. Physical Processes in Earth and Environmental Sciences. Blackwell Publishing.
- Ludman, A. and Marshak, S., 2010. Laboratory manual for introductory geology (p. 480). WW Norton & Company.
- McCann, T., 2021. Pocket Guide Geology in the Field. Springer, Bonn, Germany.
- Pelletier, J. D. 2008. Quantitative Modeling of Earth Surface Processes (Vol. 304). Cambridge: Cambridge University Press. Chicago.
- Rutford, R.H., and Carter, J.L., 2018. Zumberge's Laboratory Manual for Physical Geology, Sixteenth Edition, Mc-Graw-Hill Education, New York, USA.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 2: ENVIRONMENTAL PHYSICS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
ENVIRONMENTAL PHYSICS	4	2	0	2	Class XII pass	NIL

Learning Objectives

- Build conceptual understanding of the environment by understanding the underlying principles of physics governing environmental processes
- Develop perspective on the concepts of physics associated with the movement of particles,
- chemicals, and gaseous across the environmental compartments
- Gain insights into physics of plant-soil-water interface determining ecosystem processes

Learning outcomes

After this course, students will be able to
• Apply principles of physics to manage soil, water, and plant growth, especially in extreme environment

• Acquire skills to predict and manage pollutant movement across the environmental phases using concepts of physics
• Assess the impact of change in soils properties and field data at the microscale on tracking environmental contaminants
• Analyse soil particle size fractions and determine their impact on the movement of water and other solutes
• Correlate environmental processes in the ocean and terrestrial ecosystems on weather and climate 16
• Use satellite data to interpret radiation data and its impact on living organisms and ecosystems

SYLLABUS OF DSC-2

UNIT – I Environmental spectroscopy (6 hours)

Basic concepts of light and matter; quantum mechanics (relation between energy, wavelength and frequency), black body radiation, Kirchhoff's law, Boltzmann equation, Introduction to the concept of absorption and transmission of light, Beer–Lambert law, photovoltaic and solar cells.

UNIT – II Ocean and Atmosphere (6 hours)

Oceanic waves and circulation, Atmospheric temperature, pressure, circulation, precipitation and other features, Lapse rate (dry and moist adiabatic), Scattering of light, Rayleigh and Mie scattering, Electromagnetic radiations and spectrum, Greenhouse effect.

UNIT – III Soil and Water Physics (6 hours)

Phase transition of water and its consequences for marine and freshwater life, and rock structures, Clausius–Clapeyron equation of thermodynamics and liquid–vapor phase transition, Soil temperature and heat flow, Aggregation of soil particle size fractions, Stress, strain and strength of soil bodies, Diffusion and dispersion in soils and water. Redistribution, retention and evaporation of soil moisture and gaseous components

UNIT – IV Movement of pollutants in environment (6 hours)

Diffusion and dispersion, point and area source pollutants, pollutant dispersal; Gaussian plume model, mixing heights, hydraulic potential, Darcy's equation, types of flow, turbulence

UNIT – V: Eco-physics (6 hours)

Soil–Plant–Water Relations, Water entry into soil, Water and energy balance, Plant up take and water use efficiency; Open or closed ecosystems, Macroscopic flows of matter or energy, Disturbance or catastrophe and phase space changes in ecosystems, Thermodynamic entropy, Ecosystem efficiency, Simulated landscapes.

Practical component (if any) – (60 hours)

1. Analyze the variations in hydraulic conductivity of different soil types
2. Determine the soil temperature and thermal conductivity in different soil particle size fractions
3. Find association between heat transfer ability and the soil types
4. Estimate radon released by different materials with time
5. Monitor the health of green plants and variations in photosynthesis with varying fluorescence

6. Interpret the Gaussian plume model for the movement of pollutants in the environment.
7. Analyze the principle and applications of black body radiation and Beer–Lambert law.
8. Simulate the meteorogram of any geographical region and interpret it.

Suggestive readings

- Boeker, E. & Grondelle, R. 2011. Environmental Physics: Sustainable Energy and Climate Change. Wiley.
- Borghese, F., Denti, P. and Saija, R., 2007. Scattering from Model Nonspherical Particles:Theory and Applications to Environmental Physics. Springer Science & Business Media.
- Forinash, K. 2010. Foundation of Environmental Physics. Island Press.
- Monteith, J. and Unsworth, M., 2013. Principles of Environmental Physics: Plants, Animals, and the Atmosphere. Academic Press.
- Smith, C., 2004. Environmental Physics. Routledge.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 3: ENVIRONMENTAL CHEMISTRY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite o f the course (if any)
		Lecture	Tutorial	Practical/ Practice		
ENVIRONMENTAL CHEMISTRY	**4**	**2**	**0**	**2**	**Class X II pass**	**NIL**

Learning Objectives

• Design strategies based on principles of environmental chemistry to The Learning Objectives of this course are as follows:
•Develop concepts of environmental chemistry as a fundamental principle of various environmental processes
•Link pollutant chemistry as a basis of pollution potential of contaminants
•Gain insights into chemical reactions that govern the movement of chemical contaminants across the environmental compartments and develop solutions that influence pollutant chemistry.

Learning outcomes

The Learning Outcomes of this course are as follows:

• Synthesize knowledge on the structure and functions of environmental compartments based on the principles of environmental chemistry
• Acquire analytical and technical skills to recognize and estimate different environmental chemicals
• Apply concepts of environmental chemistry to develop low-cost methods to treat potable and industrial wastewater and manage the quality of water, soil, and air
• Relate and interpret the contaminants exposure and its adverse impacts on living organisms and the health of ecosystems
influence the environmental fate of contaminants
• Discuss global environmental issues in the background of the chemistry of pollutants

SYLLABUS OF DSC-3

UNIT – I Fundamentals of environmental chemistry (10 hours)
Atomic structure, electronic configuration, periodic properties of elements (ionization potential, electron affinity and electronegativity), types of chemical bonds (ionic, covalent, coordinate and hydrogen bonds); mole concept, molarity and normality, quantitative volumetric analysis.

Thermodynamic system; types of chemical reactions; acids, bases and salts, solubility products; solutes and solvents; redox reactions, concepts of pH and pE, electrochemistry, Nernst equation, electrochemical cells.

Basic concepts of organic chemistry, hydrocarbons, aliphatic and aromatic compounds, organic functional groups, polarity of the functional groups, synthesis of xenobiotic compounds like pesticides and dyes, synthetic polymers.

UNIT – II Atmospheric chemistry (8 hours)
Composition of atmosphere; photochemical reactions in atmosphere; smog formation, types of smog (sulphur smog and photochemical smog), aerosols; chemistry of acid rain, case studies; reactions of NO2 and SO2; free radicals and ozone layer depletion, role of CFCs in ozone depletion.

UNIT – III Water chemistry (6 hours)
Chemical and physical properties of water; alkalinity and acidity of water, hardness of water, calculation of total hardness; solubility of metals, complex formation and chelation; colloidal particles; heavy metals in water

UNIT – IV Soil chemistry (6 hours)
Soil composition; relation between organic carbon and organic matter, inorganic and organic components in soil; soil humus; cation and anion exchange reactions in soil; nitrogen, phosphorus and potassium in soil; phenolic compounds in soil.

Practical component (if any) - (60 hours)

1. Prepare buffers/solutions of different molarity and normality using the given stocks solutions

2. Determine the variations in pH of different soils and water samples using various methods.
3. Estimate hardness of given water samples
4. Determine cation exchange capacity of given soils samples
5. Determine the suitability of water for use for agriculture, industrial and domestic purposes based on selected water parameters
6. Estimate contents of selected heavy metals in given water and soil samples and identify their possible sources
7. Analyse variations in air quality index of different regions and correlate with anthropogenic or natural factors
8. Estimate organic matter contents in different soil types
9. Assess soil health based on the concentration of selected macro elements

Suggestive readings

- Beard, J.M. 2013. Environmental Chemistry in Society (2nd edition). CRC Press.
- Connell, D.W. 2005. Basic Concepts of Environmental Chemistry (2nd edition). CRC Press.
- Girard, J. 2013. Principles of Environmental Chemistry (3rd edition). Jones & Bartlett.
- Harnung, S.E. & Johnson, M.S. 2012. Chemistry and the Environment. Cambridge University Press.
- Hites, R.A. 2012. Elements of Environmental Chemistry (2nd edition). Wiley Sons.
- Manhan, S. E. 2000. Fundamentals of Environmental Chemistry. CRC Press.
- Pani, B. 2007. Textbook of Environmental Chemistry. IK international Publishing House.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

Common Pool of Generic Electives (GE) Courses
Offered by Department of Environmental Studies

Category - IV

GENERIC ELECTIVES (GE-1)

Credit distribution, Eligibility and Pre-requisites of the Course

Course t itle & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
ENVIRONMENT AND SOCIETY	4	2	0	2	12^{th} Pass	NIL

Learning Objectives
- Examine the relationship between the environment and society
- Enable students to understand and appreciate the role played by environment, society, and, their interface in shaping environmental decisions
- Think critically on environmental issues and different solutions
- Learning outcomes

Learning outcomes
The Learning Outcomes of this course are as follows:
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SYLLABUS OF GE-1

UNIT – I Introduction (4 hours)
Social and cultural construction of 'environment'; environmental thought from historical and contemporary perspective in light of the concepts of Gross Net Happiness and Aldo Leopold's Land Ethic

UNIT – II Issues in Environmentalism (4 hours)
Significant global environmental issues such as acid rain, climate change, and resource depletion; historical developments in cultural, social and economic issues related to land, forest, and water management in a global context; interface between environment and society.

UNIT – III Development -Environment Conflict (4 hours)
Developmental issues and related impacts such as ecological degradation; environmental pollution; development-induced displacement, resettlement, and rehabilitation: problems, concerns, and compensative mechanisms; discussion on Project Affected People (PAPs).

UNIT- IV Urbanization and environment (4 hours)

Production and consumption oriented approaches to environmental issues in Indian as well as global context; impact of industry and technology on environment; urban sprawl, traffic congestion and social-economic problems; conflict between economic and environmental interests.

UNIT – V Environment and Social Inequalities (4 hours)
Inequalities of race, class, gender, region, and nation-state in access to healthy and safe environments; history and politics surrounding environmental, ecological and social justice; environmental ethics, issues and possible solutions.

UNIT – VI Regulatory Framework (4 hours)
Brief account of Forest Conservation Act 1980 1988; Forest Dwellers Act 2008; Land Acquisition Act1894, 2007, 2011, 2012; Land Acquisition Rehabilitation and Resettlement Act 2013

UNIT- VII Community participation (6 hours)
State, corporate, civil society, community, and individual-level initiatives to ensure sustainable development; case studies of environmental movements (Appiko Movement, Chipko Movement, Narmada Bachao Andolan); corporate responsibility movement; appropriate technology movement; environmental groups and movements, citizen groups; role played by NGOs; environmental education and awareness.

Practical component (if any) - (60 hours)
1. Analyse the cultural construction of the environment in a country of your choice
2. Compare and contrast the perception of the environment in countries with varying levels of environmental quality
3. Critically evaluate the developmental status and type of environmental issues across societies from regu within a country and different countries.
4. Determine the socio-demographic and industrial characteristics of a region and correlate them with the environmental issues of that region?
5. Identify the relationship between societies varying in cultures and environment and analyse the role of economic factors in changing the relationship over time
6. Show any relationship between natural resource use and changing population dynamics of the community
7. Evaluate the pattern of natural resource use by people and their likelihood of participating in the conservation of natural resources
8. Demonstrate any pattern between the resources use and population dynamics, industrial activities, and employment generation in a given region
9. Analyse attitudes, knowledge, and values towards an environmental resource of a population or stakeholder and what trade-off is the public willing to make for conservation of the resource.
10. Determine access to resources across members of a society and suggest measures for equitable sharing of resources or associated benefits, if required.
11. Select an environmental policy/regulation and identify its impact on society over time.

Suggestive readings

1. Cárdenas, J.C., 2009. Experiments in environment and development. Annual Review of Resource Economics, 1(1), pp.157-82.
2. Chokkan, K.B., Pandya, H. & Raghunathan, H. (eds). 2004. Understanding Environment. Sagar Publication India Pvt. Ltd., New Delhi.
3. Elliot, D. 2003. Energy, Society and Environment, Technology for a Sustainable Future. 30 Routledge Press.
4. Ioris, A.A.R. ed., 2021. Environment and Development: Challenges, Policies and Practices. Springer Nature.
5. Leopold, A. 1949. The Land Ethic. pp. 201-214. Chicago, USA.

6. National Research Council (NRC). 1996. Linking Science and Technology to Society'sEnvironmental Goals. National Academy Press.
7. Stanton, C.Y., 2014. Experiments in Environment and Development. Stanford University.

GENERIC ELECTIVES (GE-2)

Credit distribution, Eligibility and Pre-requisites of the Course

Course t itle & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
HUMAN WILDLIFE CONFLICT AND MANAGEMENT	**4**	**2**	**0**	**2**	**12th Pass**	**NIL**

Learning Objectives

- Analyze causal factors determining conflicts between humans and wildlife
- Gaining insights into complexity of habitat sharing between wildlife and human societies Acquire deeper understanding of causal factors of habitat shrinkage and its impact on wild life dynamics and threats and benefits to human societies
- Reveal the nexus between humans-culture-economy-wildlife
- Develop scientific and social perspective of wildlife conservation.

Learning Outcomes

After successful completion of this course, students will be able to:

- Develop clear perspective on human-wildlife conflict by defining and examining its historical & present-day status
- Discriminate the underlying factors associated with successful & unsuccessful efforts on providing solutions to human-wildlife conflicts
- Demonstrate the relevance of cultural factors in understanding the issues and providing acceptable and practical solutions
- Critically evaluate different case studies for identifying factors that may have major impact in resolving human-wildlife conflicts

SYLLABUS OF GE-2

UNIT – I Introduction to wildlife management (4 hours)

Need of environmental management; wildlife conservation: moral obligation? philosophy of wildlife management; why is it necessary to worry about human wildlife conflicts? What is the role of government, wildlife biologists and social scientists, concept of deep and shallow ecology.

UNIT – II Evolution of the concept of wildlife management (6 hours)

Journey of mankind from predator to conservator; prehistoric association between wildlife and humans: records from Bhimbetka wall paintings; conservation of wildlife in the reign of king Ashoka: excerpts from rock edicts; Bishnoi community; understanding wildlife management, conservation and policies regarding protected areas in 21st century; positive values provided by wildlife conservation (monetary, recreational, scientific and ecological benefits)

UNIT – III Wildlife conservation laws in India (4 hours)
Types of protected areas (Wildlife Sanctuaries, National Parks, Biosphere Reserves); IUCN categories of protected areas, Natural World Heritage sites; concept of core and buffer area in a protected range, brief introduction to Wildlife Protection Act of 1972, Forest act 1927, Environmental Protection Act 1986, and Forest conservation Act 1920; introduction of Tiger task force, Status of current protected areas in India.

UNIT – IV Socio-economic and legal basis of conflicts (6 hours)
Concepts of development and encroachment, who is the intruders: human or animal? Impact of conflict on humans and wildlife, impact of habitat fragmentation, social inequality in terms of forest conservation: luxury hotels within protected areas vs. displacement of native tribes, forest produce as a need vs. forest exploitation, introduction to tribal rights in India, demographic profile of tribes in India, importance of forest produce to tribal populations, Scheduled tribes and other traditional Forestdwellers (Recognition of forest right) Act, 2006.

UNIT – V Wildlife conflicts (4 hours)
Insight into the important conflicts: Keoladeo National park conflict of Bharatpur, Human and elephant conflicts of Kerala, Fisherman and tiger conflict of Sundarbans forest, shifting cultivation in North east India.

UNIT—VI Human wildlife coexistence (6 hours)
Symbiotic relationship between tribals and forest, forest and development, focus on the inclusive growth of tribes: community participation in forest management, case study of Chipko movement, sacred groves forests, India's Bishnoi community and their conservation practices; ecological- economic welfare and development: conservation of indigenous culture and traditions, role of international organizations: Man and biosphere programmes; concept of conservation reserves and community reserves, importance of wildlife corridors in minimizing the conflicts and conservation.

Practical component (if any) -

1. Prepare a case study that has potential to develop as a human-wildlife conflicts in the area of your choice.
2. Write a case study describing different aspect of human-wildlife conflict and depict all associated factors in a schematic diagram
3. Using a case study, demonstrate the importance of historical facts in providing solutions in the present day
4. Evaluate merits and demerits of multistage sampling technique while collecting information on human-wildlife conflicts
5. Develop a questionnaire to identify the causal factors of human-wildlife conflicts emerging in a target regions
6. Analyze the roles of psychological factors in development of human-wildlife conflicts
7. Evaluate the relationship between resource scarcity and abundance in determining humanwildlife conflicts
8. Correlate the success and failure in resolving human-wildlife conflicts with existence of institutional framework

9. Use methods of triangulating information, field observations, photography and Problem Animal Control Report as complementary methods to focused interviews to understand the problem and suggest the solution
10. Understanding the significance of mediation among different policies on societal benefits and wildlife conservation to resolve human-wildlife conflicts

Suggestive readings

1. Angelici, F.M. and Rossi, L., 2020. Problematic Wildlife II. Springer International Publishing.
2. Conover, M. 2001. Resolving Human Wildlife Conflicts, CRC Press.
3. Conover, M.R. and Conover, D.O., 2022. Human-Wildlife Interactions: From Conflict to Coexistence. CRC Press.
4. Dickman, A. J. 2010. Complexities of conflict: the importance of considering social factors foreffectively resolving human–wildlife conflict. Animal Conservation 13: 458-466.
5. Hill, C.M., Webber, A.D. and Priston, N.E. eds., 2017. Understanding conflicts about wildlife: A Biosocial Approach (Vol. 9). Berghahn Books.
6. Manfred, M.J., 2008. Who Cares About Wildlife? Social Science Concepts for Exploring Human-wildlife Relationships and Conservation Issues.
7. Messmer, T. A. 2000. The emergence of human–wildlife conflict management: Turning challenges into opportunities. International Biodeterioration & Biodegradation 45: 97-102.
8. Nyhus, P.J., 2016. Human–wildlife conflict and coexistence. Annual Review of Environment and Resources, 41, pp.143-171.
9. Warrier, R., Noon, B.R. and Bailey, L.L., 2021. A framework for estimating human-wildlife conflict probabilities conditional on species occupancy. Frontiers in Conservation Science, p.37.
10. Woodroffe, R. 2005. People and Wildlife: Conflict and Coexistence. Cambridge.

GENERIC ELECTIVES (GE-3)

Credit distribution, Eligibility and Pre-requisites of the Course

Course t itle & Code	**Credits**	**Credit distribution of the course**			**Eligibility criteria**	**Pre-requisite o f the course**
		Lecture	**Tutorial**	**Practical/ Practice**		
GENDER AND ENVIORNMENT	**4**	**2**	**0**	**2**	**12th Pass**	**NIL**

Learning Objectives

The paper is designed to expose students to the concept of gender in society and its relevance in the environmental context. The principal objective of the course is to enable students to examine environmental issues from a gender-sensitized perspective

Learning outcomes

After the course, students will be able to:

- Identify causal factors of making woken more vulnerable to environmental calamities and issues
- Reveal the reality of gender inequalities across the countries, challenging the development of risk resilient individuals and communities
- Demonstrate significant contributions of women as stakeholders while decisions making, educating, and evolving action plans across sectors to provide long-term solutions to environmental problems.
- Show the women’s role as a leader in transitioning toward equitable and sustainable societies and industries

SYLLABUS OF GE-3

UNIT – I Introduction (4 hours)
The socially constructed ‘gender’ concept

UNIT – II Gender and society (6 hours)
Gender existence in society; gender: matriarchy and patriarchy as means of social exclusion (case studies in an Indian context); gender equity issues in rural and urban settings.

UNIT – III Gender and the environment (4 hours)
Relevance of the concept in an environmental context; evolution of gender hierarchies in historical and contemporary perspective; gendered division of roles in cultural, social and economic perspective; gender inequalities

UNIT – IV Gender, resources and the environment (4 hours)
Knowledge about the environment among men and women; differential dependencies on environmental resources; implications of gendered responses to environmental degradation.

UNIT – V Gender and environmental management (6 hours)
Women’s participation in environmental movements and conservation; historical and contemporary case studies; role of women in environmental education, awareness and sustainable development.

UNIT – VI Strategies for change (6 hours)
Need for gender equity; Instruments for change: education, media, action groups, policy and management; equity in resource availability and consumption for a sustainable future

Practical component (if any) -

1. Using a case study, demonstrate the value of a gender-inclusive approach in the success of the environmental protection programme
2. Develop a context and show the importance of women’s role in environmental conservation by emphasizing gender gaps in access to (a) power, (b) education, (c) markets, and (d) cultural practices.
3. Analyze the national gender policy or laws restricting or promoting women's participation in resolving environmental issues
4. Critically evaluate the national environmental policies for their gender sensitivity by taking an example of climate change-related policies across the sectors, including agriculture, forestry, and water.

5. Identify the gender gaps in policies related to climate change, energy access, natural resource access, and ecosystem services benefits
6. Determine the gender gaps in livelihood activities depend on ecological resources, such as agriculture, fisheries, and forestry, access to new technologies, and capacity-building in STEM (science, technology, engineering, or mathematics) for resolving environmental issues
7. Examine the impact of environmental awareness programmes involving or targeting women, especially to reduce vulnerability to climate change, access to renewable energy, sill development in energy entrepreneurship
8. Find out the variations in perspectives of women and men on environmental security across the societies within and outside country
9. Focused survey in neighbourhood community to gain insights into perception and solution to same environmental issues locally, nationally, and globally
10. Develop an action plan to address an environmental issue selected in practical 9 by incorporating livelihood strategies and economic and decision-making empowerment for women
11. Collect sex-disaggregated data and analyze the success of different environmental conservation programme based on the role of gender while focusing on involvement in decision making, participation in the action plan, the target of information dissemination, avenues of communication, major beneficiaries, and marginalized groups.

Suggestive readings

1. Agarwal, B. 2001. Participatory exclusions, community forestry, and gender: An analysis forSouth Asia and a conceptual framework. World Development 29: 1623-1648.
2. Agarwal, B., 2019. The gender and environment debate: Lessons from India. In Population and environment (pp. 87-124). Routledge.
3. Buckingham, S., 2005. Gender and Environment. Routledge.
4. Gaarder, E., 2011. Women and the animal rights movement. In Women and the Animal Rights Movement. Rutgers University Press.
5. Jackson, C. 1993. Doing what comes naturally? Women and environment in development.World Development 21: 1947-63.
6. Leach, M. 2007. Earth Mother myths and other ecofeminist fables: How a strategic notion roseand fell. Development and Change 38: 67-85.
7. MacGregor, S. ed., 2017. Routledge Handbook of Gender and Environment. Taylor & Francis.
8. Miller, B. 1993. Sex and Gender Hierarchies. Cambridge University Press
9. Oswald Spring, Ú., 2008. Gender and disasters: human, gender and environmental security. UNU-EHS.
10. Rodríguez-Labajos, B. and Ray, I., 2021. Six avenues for engendering creative environmentalism. Global Environmental Change, 68, p.102269.
11. Stein, R. (ed.). 2004. New Perspectives on Environmental Justice: Gender, Sexuality, and Activism. Rutgers University Press.
12. Stephens, A., Lewis, E.D. and Reddy, S., 2018. Towards an inclusive systemic evaluation for the SDGs: Gender equality, environments and marginalized voices (GEMs). Evaluation, 24(2), pp.220-236.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVES (GE-4)

Credit distribution, Eligibility and Pre-requisites of the Course

Course t itle & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
GREEN TECHNOLOGIES	**4**	**2**	**0**	**2**	**12th Pass**	**NIL**

Learning Objectives

- Gain insights into interdisciplinary aspects of green systems and the environment, and sustainability
- Develop a new perspective on product life cycles for improving efficiency and promoting environmental conservation
- Understand product formulation, process complexity, and infrastructure design to promote sustainability
- Integrate technical and scientific skills for environmental security and industrial sustainability for nation's development

Learning outcomes

Apply principles of green chemistry for environmentally safe products

- Design processes that rely on using environmentally benign chemicals and developing economically viable products
- Minimize environmental hazards by improved design for developing industrial products
- Using biotechnology to improve industrial methods and chemical processes as less or non hazardous, green, safe, and economically acceptable.
- Implement a combination of technical and scientific skills to understand environmental problems better, use resources, manage waste, and develop green infrastructure

SYLLABUS OF GE-4

Unit I: Green technologies (6 hours)

Definition and concepts: green technology, green energy, green infrastructure, green economy, and, green chemistry; sustainable consumption of resources; individual and community level participation such as small-scale composting pits for biodegradable waste, energy conservation; encouraged use of public transport instead of private transport; 3 R's of green technology: recycle, renew and reduce;
paradigm shift from 'cradle to cradle' to 'cradle to grave'

Unit II: Green infrastructure, planning and economy (6 hours)

Green buildings; history of green buildings, need and relevance, construction, costs and benefits; LEED certified building; Eco-mark certification: importance and implementation;

Green planning: role of governmental bodies, land use planning, concept of green cities, waste reduction and recycling in cities,
role of informal sector in waste management, public transportation for sustainable development, green belts. ; Introduction to UNEP's green economy initiative, inclusive economic growth of the society, REDD+ initiative, and cap and trade concept; green banking.

Unit III: Applications of green technologies (6 hours)

Increase in energy efficiency: Energy efficient fume hoods, motion detection lighting, or programmable thermostats. Green House Gas (GHG) emissions reduction: carbon capture and storage (CCS) technologies, purchase and use of carbon offsets, alternative forms of transportation for employees, such as carpools, fuel efficient vehicles, and mass transit, methane emissions reduction and/or reuse).Pollution reduction and removal: Physico-chemical and biological methods

Unit IV: Green chemistry (6 hours)

Introduction to green chemistry; principles and recognition of green criteria in chemistry; bioAnnexure-VII38 degradable and bio-accumulative products in environment; green nanotechnology; reagents, reactionsand technologies that should be and realistically could be replaced by green alternatives;photodegradable plastic bags**.**

Unit V: Green future (6 hours)

Agenda of green development; reduction of ecological footprint; role of green technologies towards a sustainable future; major challenges and their resolution for implementation of green technologies; green practices to conserve natural resources (organic agriculture, agroforestry, reducing paper usage and consumption, etc.); emphasis on waste reduction instead of recycling, emphasis on innovation for green future; role of advancement in science in developing environmental friendly technologies.

Practicals/Hands-on Exercise

1. Analyze practices of an industry of your choice from India and outside country that has adopted green technology for brand image and economic edge
2. Identify, explain and discuss the ecological principles adopted by the industry selected in practical 1 and analyze their importance
3. Select an industry of your choice where cleaner production is required to improve quality of life and weight its economic, social, and environmental costs
4. Recommend clean development mechanisms and methods of converting waste into wealth in an industry that plays a significant role in your native area or the nation's GDP.
5. Develop a plan for carbon credit and carbon trading where it is not prevalent so far and compare it with a similar plan from a developing or developed country
6. Conduct a Life Cycle Assessment and its elements of a product widely used in your family or residential complex and recommend methods/processes that can help achieve a green tag.
7. Compare and contrast the use of conventional and non-conventional energy sources in your state or country and devise a method for transitioning completely to complete green energy
8. Assess the types and quantity of biomass used as an energy source in your country and evolve a plan to switch towards greener methods in the next 5 years

9. Develop a feasibility status of developing and integrating solar, wind, tidal, and geothermal energy in your nation
10. Evolve an action plan for water recycling for your residential complex by considering the quantity available, type of usage, and existing infrastructure
11. Analyze a case study of commercial green building in your state and discuss the ecological principle(s) adopted for this purpose.

Suggested Readings

1. Allen, D.T., 2012. Sustainable Engineering: Concepts, Design, and Case Studies. Pearson
2. Anastas, P.T. & Warner, J.C. 1998. Green Chemistry: Theory & Practice. Oxford UniversityPress.
3. Arceivala, S.L. 2014. Green Technologies: For a Better Future. Mc-Graw Hill Publications.
4. Baker, S. 2006. Sustainable Development. Routledge Press.
5. Floyd. A., 2011. Green Building: A Professional's Guide to Concepts, Codes and Innovation. Delmar Cengage Learning
6. Hrubovcak, J., Vasavada, U. & Aldy, J. E. 1999. Green technologies for a more sustainable agriculture (No. 33721). United States Department of Agriculture, Economic Research Service.
7. Striebig, B., Ogundipe, A.A. and Papadakis, M., 2015. Engineering applications in sustainable design and development. Cengage Learning.
8. Thangavel, P. & Sridevi, G. 2015. Environmental Sustainability: Role of Green Technologies. Springer Publications.
9. Vallero, D.A. and Brasier, C., 2008. Sustainable Design: The Science of Sustainability and Green Engineering. John Wiley & Sons.
10. Woolley, T. & Kimmins, S. 2002. Green Building Handbook (Volume 1 and 2). Spon Press

DEPARTMENT OF HOME SCIENCE

BSc. (Hons.) Home Science

Category-II

DISCIPLINE SPECIFIC CORE COURSE – 1 (DSC-HH101) Human Development I: The Early Years

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Human Development I: The Early Years	**4**	**3**	**0**	**1**	**Class XII with Science**	**-**

Learning Objectives

1. To develop an understanding about the discipline of Human Development
2. To gain an insight of development in different domains from conception to early childhood

Learning outcomes

After completing this course, students will be able to:

1. Develop an understanding about the discipline of Human Development
2. Acquire knowledge of development in different domains from conception through infancy and early childhood.
3. Understand the salient features of human development by getting acquainted with various methods of studying children.

SYLLABUS

Unit I: Introduction to Human Development (9 hours)

Unit Description: The unit presents the student with an overview of the discipline of Human Development. The student will develop an understanding of basic ideas and terms that are central to the study of Human Development.

Subtopics: ● Human Development: Definitions, nature and scope ● Domains and stages of development ● Principles of development ● Contexts of development

Unit II: Prenatal development and childbirth (9 hours)

Unit Description: The unit describes the process of development from conception to birth and elaborates on the hereditary and environmental influences that play a role in prenatal development

Subtopics: ● Conception and stages of prenatal development ● Influences on prenatal development ● Prenatal care ● Childbirth: Methods and birth complications

Unit III: Neonate and infant development (12 hours)

Unit Description: The unit draws focus to the first two years of life and provides an understanding of the physical-motor, socio-emotional, cognitive and language development of infants.

Subtopics: ● Capacities of the neonate ● Infant care practices ● Physical motor development ● Socio-emotional development ● Language development ● Cognitive development

Unit IV: Development during early childhood (12 hours)

Unit Description: The unit traces the progression in development that occurs from 2-6 years of life.

Subtopics: ● Physical Motor Development ● Socio-Emotional Development ● Language Development ● Cognitive Development

PRACTICAL (30 hours)

Unit 1 ● Narrative method: recalling and recording an event ● Exploring cultural practices and traditions during - Pregnancy - birth - Infant care

Unit 2 ● Observation method: - observing infants and preschool children in everyday settings - recording the observations ● Neonatal assessment (APGAR scale and Neonatal reflexes) ● Multi-media resources to study prenatal development, infancy, early childhood

Essential readings

1. Berk, L. (2013). Child development. 9th ed. Boston: Pearson.
2. DECE-1 Organising Child Care Services (IGNOU Study Material) https://www.egyankosh.ac.in/handle/123456789/32288
3. Dixit, A. (2019). Baal Vikas (1st ed.). Doaba House.
4. Journey of the first 1000 days: Rashtriya Bal Swasthya Karyakram (2018) Ministry of Health and Family Welfare.
5.https://nhm.gov.in/images/pdf/programmes/RBSK/Resource_Documents/Journey_of_The_Fi rst_1000_Days.pdf
6. Patni, M. (2020). Baal Vikas (3rd ed.). Star Publications.
7. Santrock, J.W. (2011). Life-span development. New York: McGraw-Hill.
8. Singh, A. (Ed.) 2015. Foundations of Human Development. New Delhi: Tata McGraw
9. Hill. Chapter 2,
10. Snow, C.W. (1997). Infant Development. New Jersey, Prentice-Hall Inc.

Suggested Readings

1. Joshi, P. & Shukla, S. (2019). Child development and education in the twenty-first century. Singapore: Springer International
2. Khalakdina, M. (2008). Human development in the Indian context: A socio - cultural focus: 1. India: Sage.

DISCIPLINE SPECIFIC CORE COURSE – 2 (DSC-HH 102) Food Science and Nutrition

Credit distribution, Eligibility and Prerequisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Food Science and Nutrition	4	3	0	1	Class XII With Science	-

Learning Objectives

1. To understand the relationship between food, nutrition and health.
2. To describe the function of various nutrients and list their sources.
3. To understand the nutritional contribution of and effect of cooking on different food groups.
4. To describe ways of reducing nutrient losses during cooking and methods of enhancement of nutritional quality of foods.
5. To be able to prepare dishes using principles of food science.

Learning outcomes

After completing this course, students will be able to:
1. Understand the relationship between food, nutrition and health.
2. Describe the digestion, absorption and function of various nutrients and list their sources.
3. Understand the nutritional contribution of and effect of cooking on different food groups.
4. Understand ways of reducing nutrient losses during different methods of cooking and methods of enhancement of nutritional quality of foods.
5. Prepare dishes using principles of food science and assess serving size and nutritional contribution.

SYLLABUS OF DSC- 2

Unit I: Basic Concepts in Food and Nutrition (5 hours)

Unit Description: An introduction to the sciences of food and nutrition and their relationship to health and disease.

Subtopics: ● Basic terms used in study of food and nutrition ● Understanding relationship between food, nutrition and health ● Functions of food-Physiological, psychological and social

Unit II: Nutrients (15 hours)

Unit Description: Functions, dietary sources and clinical manifestations of deficiency/ excess of the nutrients

Subtopics: ● Energy, Carbohydrates, lipids and proteins ● Fat soluble vitamins ● Water soluble vitamins ● Minerals

Unit III: Food groups (15 hours)

Unit Description: Structure, composition, products, nutritional contribution, selection and changes during cooking of various food groups

Subtopics: ● Cereals and Pulses ● Fruits and vegetables ● Milk & milk products ● Eggs ● Meat, poultry and fish ● Fats and Oils ● Spices and herbs ● Beverages

Unit IV: Methods of Cooking and Enhancing the Nutritional Quality of Foods (10 hours)

Unit Description: Different methods of cooking and ways to improve nutrient retention or improve nutritional quality

Subtopics: ● Dry, moist, frying and microwave cooking ● Advantages, disadvantages and the effect of various methods of cooking on foods ● Preventing losses of nutrient during cooking ● Improving nutritional quality of diets by Food synergy, Germination, Fermentation, Fortification and Genetic Modification of foods

Practical component – 30 Hours

Unit I ● Weights and measures; preparing market order and table setting

Unit II Food preparation, understanding the principles involved, nutritional quality and portion size- ● Cereals: Boiled rice, pulao, chapati, paratha-plain/stuffed, poori, pastas ● Pulses: Whole, dehusked, pulse curry ● Vegetables: Dry preparation, vegetable curry ● Milk preparations: Kheer, porridge, custard ● Egg preparations: Boiled, poached, fried, scrambled, omelettes, egg pudding ● Soups: Plain and cream soups ● Baked products: cakes, biscuits/cookies ● Snacks and Breakfast Cereals: pakoras, cutlets, samosas, cheela, upma/poha, sandwiches ● Salads: salads and salad dressings

Essential readings

1. Chadha R and Mathur P (eds)(2015). Nutrition: A Lifecycle Approach. Hyderabad: Orient Blackswan.
2. Rekhi T and Yadav H (2014). Fundamentals of Food and Nutrition. New Delhi: Elite Publishing House Pvt Ltd.
3. Srilakshmi B (2014). Food Science, 6th Edition. Delhi: New Age International Ltd.
4. Khanna K, Gupta S, Seth R, Mahna R, Rekhi T (2004). The Art and Science of Cooking: A Practical Manual, Revised Edition. New Delhi: Elite Publishing House Pvt Ltd.
5. Raina U, Kashyap S, Narula V, Thomas S, Suvira, Vir S, Chopra S (2010). Basic Food Preparation: A Complete Manual, Fourth Edition. Hyderabad: Orient Black Swan

Suggestive readings (if any)

1. Bamji MS, Krishnaswamy K, Brahmam GNV (2016). Textbook of Human Nutrition, 4th edition. New Delhi: Oxford and IBH Publishing Co. Pvt. Ltd.
2. Byrd-Bredbenner C, Moe G, Beshgetoor D, Berning J. (2013). Wardlaw's Perspectives in Nutrition, International Edition, 9th edition, New York: McGraw- Hill.
3. Sethi P, Lakra P. Aahar Vigyan, Poshan evam Suraksha (Hindi); First Ed; 2015; Delhi: Elite Publishing House (P) Ltd.

DISCIPLINE SPECIFIC CORE COURSE– 3 (DSC-3) COMMUNICATION CONCEPTS AND THEORIES

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Communication Concepts and Theories	4	3	0	1	Class XII pass with Science	

Learning Objectives

1. To learn about the concept, nature, and scope of communication.
2. To understand the process of communication with the help of theories, models, and elements of communication.
3. To recognize and appreciate the role of Perception, Empathy, Persuasion, Culture and Listening in communication.
4. To be able to comprehend the various communication transactions and their role in day-to day life with special reference to public communication.
5. To understand the relationship between culture and communication and its applications in real life settings.

Learning outcomes

The students would be able to:
1. Develop a clear understanding of the concepts of human communication.
2. Comprehend the elements and models governing the process of effective communication.
3. Gain understanding about the related concepts of communication such as Perception, Empathy, Persuasion and Listening
4. Understand the various communication transactions as well as the qualities and skills required of an effective public speaker.
5. Appreciate the role and application of factors for effective communication.

SYLLABUS OF DSC-3

Unit I: Communication: Core Concepts (10 Hours)

Unit Description: The Unit 1 explores the fundamentals of Human Communication tracing the history of communication from the olden times to the present times. It highlights the concept, nature, types, scope, and postulates of communication and discusses the functions performed through communication

Subtopics: ● Historical background, concept, nature, functions, and scope of communication ● Types of Communication – Formal and informal communication; Verbal and Non-verbal communication; Digital and Non-digital communication ● Verbal communication- Principles, types, effective use of verbal messages for communication ● Non-verbal communication- functions, types, skills, channels of non-verbal communication, inter-relationship between culture and non-verbal skills ● Elements of communication - Source, Message, Channel, Receiver, Feedback, Context, Noise & Effects

Unit II: Communication Models and Theories (10 Hours)

Unit Description: The Unit II emphasizes the models and theories of the communication process. The further delves on the importance of these models and theories for understanding the effectiveness of communication as a process.

Subtopics: ● Models of Communication: Types of models- Linear, Interaction and Transaction models, (Models by Aristotle, Harold Laswell, Shannon &Weaver, Charles Osgood, Wilbur Schramm, Helical model) ● Theories of Communication: Mass Society, Propaganda, Limited Effects, Individual Difference and Personal Influence

Unit III: Factors for Effective Communication (13 Hours)

Unit Description: The Unit delves with intricate concepts such as Empathy, Persuasion, Perception and Listening that are associated with communication. The unit also discusses the relationship between culture and communication.

● Factors for effective communication: Definitions, goals and principles of Empathy, Perception, and Persuasion ● Empathy: Concept and Theories ● Perception: Concept and Theories ● Listening in Human Communication-Listening process, significance of good listening, styles of listening, barriers to listening, culture and listening, listening theories ● Culture and communication- Relationship between culture and communication, signs, symbols and codes in communication

Unit IV: Communication Transactions and Learning (12 Hours)

Unit Description: The Unit III elucidates upon the various levels of communication transactions. This Unit in particular lays thrust on the Public communication and 'need and importance' of communication for learning. The unit also highlights the concept of communication for development.

Subtopics: ● Levels of communication transactions ● Public communication- Concept, types, techniques and skills in public speaking, qualities of an effective public speaker, overcoming speaker apprehension ● Communication, and Learning: Learning as Communication Process, Domains of Learning. Theories of learning ● Audio-Visual Aids in communication- definitions, functions, classification including Edgar Dale's Cone of Experience ● Communication for Development- Concept and approaches

Practical components – 30 Hours

● Exercises to understand visual communication: Elements of Art and Principles of Design
● Exercises to explore dimensions of non-verbal communication
● Hands on practice with different types of public speaking
● Exercises in effective listening skills
● Exercises on building empathy for effective communication
● Analysis and designing of IEC materials

Essential readings

Devito, J. (2012). Human Communication. New York: Harper & Row.

Barker, L. (1990). Communication, New Jersey: Prentice Hall, Inc; 171.

Anand, S. & Kumar, A. (2016). Dynamics of Human Communication. New Delhi: Orient Black Swan.

Vivian, J. (1991). The Media of Mass Communication. Pearson College Div; 11th edition (19 March 2012).

Punhani & Aggarwal (2014). Media for Effective Communication. Elite Publishers, New Delhi.

Suggestive readings

Patri, V. R. and Patri, N. (2002). Essentials of Communication. Greenspan Publications

Baran, S. (2014). Mass Communication Theory. Wadsworth Publishing.

Stevenson, D. (2002). Understanding Media Studies: Social Theory and Mass Communication, Sage Publications.

McQuail, D. (2000). Mass Communication Theories. London: Sage Publications.

Zeuschner, R. (1997). Communicating Today. California State University, USA.

BSC. (HONS.) FOOD TECHNOLOGY

Category-I

DISCIPLINE SPECIFIC CORE COURSE – 1 (DSC-FT01) Fundamentals of Food Technology

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Fundamentals of Food Technology	4	3	0	1	Class XII with PCM/PCB	-

Learning Objectives

1. To understand the basic principles of food science and technology.
2. To understand the structure, composition, nutritional value, changes during processing and storage of various plant and animal foods.

Learning outcomes

1. Appreciate the principles of food science and technology.
2. Attain knowledge of the structure, composition, nutritional quality and post-harvest changes in various plant foods
3. Comprehend the structure and composition of various animal foods. 4. Understand the fundamentals of various plant and animal food processing

SYLLABUS OF DSC-1

Unit I: Introduction to Food Science and Technology (4 Hours)

The unit presents the student with an overview of the food science and technology.

Unit II: Structure, Nutritional Composition and Technological aspects of Plant foods (12 Hours)

Unit Description: Cereals, Millets and Pulses

Subtopics: Introduction to cereals, nutri-cereals (millets), pseudo cereals. ● Wheat- Structure and composition, types of wheat, Diagrammatic representation of longitudinal structure of wheat grain. ● Malting, dextrinization, gelatinization, types of browning Maillard & caramelization. ● Rice- types of rice, parboiling of rice- advantages and disadvantages. ● Pulses- Introduction to pulses and legumes. ● Naturally occurring toxic constituents in pulses, types of processing- soaking, germination, decortication, cooking and fermentation.

Unit III: Structure, Nutritional Composition and Technological aspects of Plant foods (13 Hours)

Unit Description: Edible Oils, Fruits and Vegetables

Subtopics: Fats & Oils- Classification of lipids, saturated fatty acids, unsaturated fatty acids, essential fatty acids, trans fatty acids. ● Refining of oils-different methods, hydrogenation ● Rancidity –Types- hydrolytic and oxidative rancidity and its prevention. Fruits & Vegetables- Classification of fruits and vegetables, composition, pigments, types of fibre. ● Enzymatic browning and its prevention, ● Post-harvest changes in fruits and vegetables – Climacteric and non-climacteric, ripening, physicochemical changes-physiological and horticultural maturity, pathological changes, during the storage of fruits and vegetables.

Unit IV: Nutritional Compositional and Technological aspects of Animal foods

(16 Hours)

Unit Description: Flesh Foods - Meat, Fish, Poultry and Milk and Milk products

Subtopics: ● Meat – Definition of carcass, composition of meat, post-mortem changes in meat- rigor mortis, tenderization of meat, curing and ageing of meat. ● Fish - Classification and composition of fish, aquaculture, characteristics of fresh fish, Types of spoilage in fish- microbiological, physiological, biochemical. ● Poultry - Structure and composition of egg, egg proteins, characteristics of fresh egg, deterioration of egg quality. difference between broiler and layers. ● Milk & Milk Products- Definition of milk, composition of milk and types of market of milk, milk processing-homogenization, pasteurization.

Practical component – 30 Hours

1. To study enzymatic browning in fruits & vegetables.
2. To study different types of non-enzymatic browning.
3. To study gelatinization behavior of various starches.
4. To study the concept of gluten formation of various flours.
5. To study germination.
6. To study dextrinization in foods.
7. To perform quality inspection of egg.

Essential readings

1. Bawa. A.S., Chauhan, O.P, Raju. P.S. (2013) ed. Food Science. New India Publishing Agency
2. Potter, N. N., & Hotchkiss, J. H. (2012). Food science. Springer Science & Business Media.
3. Srilakshmi, B. (2018). Food science. New Age Publishers. 7th edition.

Suggestive reading

1. De, Sukumar. (2007). Outlines of Dairy Technology. Oxford University Press
2. Kent, N.L.(2018). Kent's Technology of Cereals: An introduction for students of food science and agriculture. Elsevier. 5th edition.
3. Meyer. (2006). Food Chemistry. CBS publishers and distributors.
4. Stewart, G.F., &Amerine, M.A.(2012). Introduction to Food Science and Technology. Elsevier, 2nd Edition.
5. Rao, E.S. (2019) Fundamentals of Food Technology and Preservation, Variety Books, New Delhi.

DISCIPLINE SPECIFIC CORE COURSE – 2 (DSC-FT02) Principles of Food Science

Credit distribution, Eligibility and Prerequisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Principles of Food Science	**4**	**3**	**0**	**1**	Class XII with **PCM/PCB**	**-**

Learning Objectives
1. To impart basic concepts of food science, food chemistry and food sanitation.
2. To introduce the concept of food microbiology, sensory science and food packaging.

Learning outcomes
Understand the basic concepts of
1. Structure and composition, food science and food sanitation.
2. Food microbiology, sensory science and food packaging

SYLLABUS OF DSC- 2

Unit I: Surface Chemistry and Structural properties of foods (12 Hours)

Unit Description: Surface Chemistry and Structural properties of foods

Subtopic: Introduction to engineering properties of food and biomaterials, structure and chemical composition of foods, physical properties and surface chemistry (colloids, emulsions, foam, sols, gels, pectin gels) and application

Unit II: Sensory properties of foods (10 Hours)

● Basic description of taste, flavour, odour, colour and texture. ● Theories of gustation, olfaction, colour and texture. ● Techniques of sensory evaluation (Descriptive and Discriminative tests)

Unit III: Basic Food Microbiology (8 Hours)

Introduction to types of microorganisms, Food as a substrate for microorganism, bacterial growth curve, Factors affecting growth of microbes : Intrinsic and Extrinsic

Unit IV: Waste management and sanitation (9 Hours)

Properties of Waste water, hardness of water, break point chlorination, physical and chemical nature of impurities, BOD, COD, waste water treatment, detergents and sanitizers used in food industry, CIP and COP system with reference to food industry

Unit V: Introduction to Food Packaging (6 Hours)

Objectives of packaging, types of packaging materials (paper, glass, plastic, metal and wood, rigid and flexible packaging) and properties

Practical component – 30 Hours
1. Preparation and standardization of reagents
2. Determination of moisture content of food samples
3. Demonstration of fat/ protein estimation
4. Preparation of degree brix solution
5. Application of colloidal chemistry to food preparation
6. To perform sensitivity / threshold tests for basic taste
7. Introduction to microscopy and study of morphology of bacteria, yeast and mold using permanent slides.
8. Determination of alkalinity/ hardness of water
9. Determination of BOD/COD and total dissolved solids of water samples
10. Identification and testing (Thickness, GSM) of different types of packaging materials

Essential readings

- Coles, R., McDowell, D., & Kirwan, M. J. (Eds.). (2003). Food packaging technology (Vol. 5). CRC press.
- De, S. (1996). Outlines of dairy technology. Oxford University Press.
- DeMan, J. M., Finley, J. W., Hurst, W. J., & Lee, C. Y. (2018). Principles of food chemistry, 4th ed. Springer.
- Frazier, W.C. and Westhoff, D.C.(2004). Food Microbiology.New Delhi. TMH Publication
- Shadaksharaswamy, M., & Manay, N. S. (2011). Food, facts and principles. 4 th ed. New Age international publisher. New Age International.
- Meyer LH.(2006). Food Chemistry, CBS Publication, New Delhi.
- Potter N.N., Hotchkiss J.H. (2007). Food Science,5th ed. CBS Publication, New Delhi
- Ranganna, S. (2002). Handbook of Analysis of quality control for fruit and Vegetables products 2nd Ed. Tata Mcgraw Hill pub. Co. Ltd. New Delhi

Suggestive readings (if any)

- Jenkins, W.A. and Harrington, J.P. (1991). Packaging Foods with Plastics, Technomic Publishing Company Inc., USA.
- Norman, G. Marriott. and Robert, B. Gravani. (2018). Principles of Food Sanitation,6th ed. New York, Springer

DISCIPLINE SPECIFIC CORE COURSE– 3 (DSC-FT03) MILK & MILK PRODUCTS TECHNOLOGY

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course(if any)
		Lecture	Tutorial	Practical/ Practice		
MILK & MILK PRODUCTS TECHNOLOGY	**4**	**3**	**0**	**1**	**Class XII pass** with **PCM/PCB**	

Learning Objectives

1. Processing of milk and milk products at industry level
2. To know the compositional and technological aspects of milk
3. To study processed milk products

Learning outcomes

1. Understand the importance of Dairy industry
2. Understand the various properties and composition of milk.
3. Understand the technology of manufacturing of various products like Butter, ghee, Yoghurt, Dahi, Shrikhand, Ice-cream, Milk powder, channa, Paneer, Cheese (cheddar), Khoa
4. Understand market milk industry stages of milk processing and working of a few Dairy equipment’s

SYLLABUS OF DSC-3

Unit I: Physical properties of milk (7 Hours)

• Color • Taste • pH and buffering capacity • Refractive index • Viscosity • Surface tension • Freezing & boiling point • Specific heat and electrical conductivity

Unit II: Composition of milk (16 Hours)

Unit Description: Macro nutrients and micronutrients of milk; milk sugar, fat and protein.
Subtopics: • Lactose (alpha and beta forms and their differences) • Significances of lactose in dairy industry • Composition and structure • Fat constants (Saponification value, Iodine value, RM value, Polenske value, peroxide value) • Difference between casein and serum protein • Different types of casein (acid and rennet) • Uses of casein

Unit III: Market milk industry and milk products (22 Hours)

Processing of milk and milk products
Subtopics: • Systems of collection of milk reception • Platform testing • Various stages of processing; Filtration, Clarification Homogenization, Pasteurization • Description and working of clarifier, cream separator, homogenizer and plate heat exchanger • Principle of processing of following milk products -Butter, ghee, yoghurt, dahi, shrikhand, ice-cream, milk powder, channa, paneer, cheese (cheddar), khoa

Practical components – 30 Hours

1. To determine specific gravity of milk
2. To determine acidity of milk
3. To perform COB test in milk
4. To estimate milk protein by Folin method
5. To estimate milk fat by Gerber method
6. To prepare casein and calculate its yield
7. To perform MBRT test in milk
8. Schematic diagram of pasteurization of milk in dairy industry
9. Study energy regeneration in dairy industry
10. Study and schematic diagram of CIP in dairy industry

Essential readings

● De, Sukumar. (2007). Outlines of dairy technology. Oxford University Press.
● Webb B.H.and Alford (2005). Fundamentals of dairy chemistry. CBS Publisher.

Suggestive readings

● P.F. Fox, T. Uniacke-Lowe and J.A.O’ Mahony (2005). Dairy Science and Technology. Taylor & Francis.
● P. Walstra, Jan T.M. Wouters and Tom J. Geurts (2015). Dairy chemistry and Biochemistry. Springe.

BSC. (PROG.) HOME SCIENCE
Category-II

DISCIPLINE SPECIFIC CORE COURSE – 1 (DSC-1) –: INTRODUCTION TO RESOURCE MANAGEMENT

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Introduction to Resource Management	**4**	**3**	**-**	**1**	**Class XII pass**	**-**

Learning Objectives

The Learning Objectives of this course are as follows:

1. To comprehend the fundamentals of resource management, their purpose and utilization in today's context and conservation approaches.
2. To understand the functions and processes of management in a scientific manner for optimum use of resources.

Learning outcomes

The Learning Outcomes of this course are as follows:

The students will be able:

1. Comprehend the concept and fundamentals of resource management in a changing scenario.
2. Acquaint themselves with the available resources, their uses and conservation approaches.
3. Utilize resources in an efficient and judicious manner.
4. Understand the functions and processes of management in a scientific manner for the optimum use of resources.

SYLLABUS OF DSC-1

UNIT – I Basics of Management (9 Hours)

This unit will develop understanding regarding the concept of management and role of motivation in management.

Subtopics:

- Concept, nature, universality and scope of management
- Theories and Approaches to Management
- Ethics in management
- Motivation in management

UNIT – II Functions of Management (12 Hours)

Students will be able to develop complete understanding of different management functions and their importance in the process of management.

Subtopics:

- Decision Making: Concept, significance and steps involved in decision-making process.
- Planning: Nature and characteristics, classification of plans & steps in planning.
- Organizing: Concept, significance and steps involved in organizing process.
- Supervision: Types of supervision (directing & guiding), factors of effective supervision.

● Controlling: Types of control, steps in controlling, requirements of effective control.
● Evaluation: Types and steps of evaluation.

UNIT – III Time and Energy Management (12 Hours)
This unit will orient the students towards application of management processes to time and energy as important resources.
Subtopics:
- Time Management: Concept, Tools of time management, types of time plans, Steps in making a time plan.
- Energy Management: Concept, principles of body mechanics, types of fatigue.
- Work Simplification: Techniques, Classes of Change.

UNIT – IV Prenatal Development (12 Hours)
Students will gain understanding of prenatal through presentations on stages of prenatal development and factors which have an impact.
Subtopics:
● Stages of prenatal development
● Factors affecting prenatal development

Practical component
Unit I: Identification and Development of managerial competencies
Activities:
● Micro Lab and Who am I
● SWOT analysis
- Self
- Case studies: Individuals
- Case studies: Organizations
● Building Decision making abilities
● Team building management games
● Decision Making through Case Analysis

Unit II: Time and Energy Management
Activities:
● Time Management:
- Evaluation of time plans through case analysis:
o Case Study - 1
o Case study - 2
- Analysis of time use pattern of self
- Preparation and evaluation of time plans
● Work improvement using time and motion study techniques
- pathway chart or travel chart / process chart - observe, record, and analyze an activity.
- pathway chart or travel chart / process chart - observe, record, and analyze an activity with improvement.

Essential readings
1. Goel, S. Ed. (2016). Management of resources for sustainable development. New Delhi: Orient Blackswan Pvt. Ltd.
2. Moore, T. J. (2021). Family resource management (4th ed.), ISBN-13: 978-1544370620.
3. Chhabra, T.N. (2020) Business Organization & Management. ISBN: 9789385071102
4. Griffin, R. W. (2016). Fundamentals of Management. Cengage Learning.

5. Griffin, R. W. (2013). Management: Principles and practices (11th ed.). South-Western Cengage Learning.
6. Rao, V.S. P. (2008). Principles & practice of management. Konark Publishers Pvt. Ltd.
7. Koontz, H., & O' Donnel, C. (2005).Management: A systems and contingency analysis of managerial functions. New York: McGraw-Hill Book Company.

Suggestive readings:

1. Kreitner, R. (2009). Management Canada: Houghton Miffin Harcourt Publishing Company.
2. Robbin, S.P. (2009). Fundamentals of management. Pearson Education.
3. Steidl, R. & Bratton, E. (1968). Work in the Home. USA: John Wiley & Sons, Inc.

DISCIPLINE SPECIFIC CORE COURSE – 2 (DSC-2): FASHION CONCEPTS

Credit distribution, Eligibility and Prerequisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
FASHION CONCEPTS	4	3	-	1	Class XII pass	-

Learning Objectives

The Learning Objectives of this course are as follows:
1. To understand the basics of fashion and the fashion industry.
2. To impart knowledge about functions and theories of clothing.
3. To develop sensitivity towards selection of garments and garment design.

Learning outcomes

The Learning Outcomes of this course are as follows:
1. Identify the role and functions of clothing and recognize the factors affecting the selection and evaluation of clothing.
2. Explain the concept of fashion, its terminology, sources and factors affecting it.
3. Being aware of global fashion centers.
4. Apply the knowledge of elements and principles in design interpretation.

SYLLABUS OF DSC- 2

UNIT – I Clothes and Us (12 Hours)

This unit introduces the student to key concepts of how and why people started to wear clothes, and what factors are at play in the current times for selecting clothing for the individual.
- Clothing functions and theories of origin
- Clothing terminology
- Individuality and conformity, conspicuous consumption and emulation
- Body shapes
- Selection and Evaluation of quality of ready-made garments
- Selection of clothes for self

UNIT – II Understanding Fashion (12 Hours)

This unit will deal with the basic concepts in understanding fashion, from key terms to the why and how of fashion and more contemporary knowledge of fast and slow fashions.
- Fashion cycle
- Terminology
- Theories of fashion adoption
- Sources of fashion research

- Factors favouring and retarding fashion
- Role of a Designer
- Fast Fashion: Characteristics of Fast Fashion, Fast Fashion and Consumer
- Slow Fashion: Characteristics, Slow Fashion as a process, importance of changing from fast to slow fashion.

UNIT – III Design in Garments (9 Hours)

This unit orients the student from a design perspective in garments; the various elements that comprise a garment and the various principles that govern and guide in developing a good design.

UNIT – IV Fashion (12 Hours)

This unit will apprise the student on the forecasting process for fashions, functioning of the industry and various garment categories for production

- Structure and Functioning of Fashion Industry
- Forecasting: Fashion seasons
- Garment Categories
- Fashion Centres
- Careers in Fashion

Practical component – 30 Hours

Unit I: Hand stitches

This unit will impart hands-on skill for making small products using upcycling of used articles of clothing or home textiles and how value addition may be achieved in garments by using popular embroidery stitches.

● Prepare samples of -

- Basic hand stitches for creating a seam and edge finishing.
- Decorative Hand Stitches

Develop an upcycled product.

Unit II: Elements & Principles of Design

This unit will train the students to identify the various elements of a design that a garment uses and the principles that create an aesthetic design. Eventually a student will be able to effectively use these elements and principles of design to create well designed garments.

- Create a collection of garments for analysis from print and visual media.
- Analyze the various elements that comprise the garments.
- Identify the various principles of design used in the selected garments

Essential readings

1. Brown, Patty, Rice J., 1998, Ready to Wear Apparel Analysis. Prentice Hall.
2. Marshall S G, Jackson H O, Stanley MS, Kefgen M & Specht T, 2009, Individuality in
3. Clothing & Personal Appearance, 6th Edition, Pearson Education, USA.
4. Tate S.L., Edwards M.S., 1982, The Complete Book of Fashion Design, Harper and Row Publications, New York.
5. Fringes G.S., 1994, Fashion From Concept to Consumer, 6th edition, Prentice Hall, New Jersey.

Suggestive readings

1. R. Andrew, 2018, Key Concepts for Fashion Industry, Bloomsbury Publishing, India.
2. Reader's Digest (Eds.). 2002, New Complete Guide to Sewing, (Canada) Ltd. Montreal.

DISCIPLINE SPECIFIC CORE COURSE – 3 (DSC-3): INTRODUCTORY LIFE SCIENCES FOR HOME SCIENCE

Credit distribution, Eligibility and Prerequisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
INTRODUCTORY LIFE SCIENCES FOR HOME SCIENCE	4	2	-	2	Class XII pass	-

Learning Objectives

The Learning Objectives of this course are as follows:

1. To introduce students to animal and plant diversity, and its significance for human life.
2. To make students aware of the fundamentals of cell structure, physiology and growth.
3. To enable students to appreciate the interdependence of ecosystems and its environmental underpinnings.
4. To make students aware of basics of immunology, genetics and biotechnological applications.

Learning outcomes

The Learning Outcomes of this course are as follows:

1. The students would be able to identify animals and plants of human concerns and ecological importance.
2. The students would be able to appreciate the existential link between plants, microbes, animals and humans.
3. The students would develop hands-on experience on plant propagation methods along with a functional understanding of plant physiology.
4. The students would understand the importance of prenatal screening, and biotechnology.
5. The student would be able to make a pedigree chart of a family and identify the inheritance pattern of a character.

SYLLABUS OF DSC- 3

Section A – Botany

UNIT – I Introduction to the Plants: Cytology, Morphology and Economic Botany (8 Hours)

Fundamentals of Plant diversity, Plant morphology and Plant Resource Utilization

Subtopics

- Introduction to Plant Diversity
- Types of a cell: Prokaryotes and Eukaryotes
- Plant cell- An Overview, Types, Structure and Function
- Angiosperm plants: Morphology (Parts of plants with modifications and Life cycle)
- Plant Nutrition and Soil: Essential Elements and Functions, Nutrient cycles, Biofertilizers, Bio-enzymes
- Introduction to Economically important plants: Fibre Crops, Medicinal Plants, Oil Crops, Timber Plants, Food Crops

UNIT – II Plant Physiology, Propagation of Plants and Gardening (7 Hours)

Basics of plant physiology, Plant propagation and Gardening
Subtopics
- Important physiological processes (Diffusion, Osmosis and plasmolysis)
- Brief account of transpiration, photosynthesis and respiration in plants
- Seed Propagation
- Vegetative Propagation: Cuttings – stem leaf and root, Layering, Grafting
- Gardening: Concept and Types with example of Kitchen Garden, Community gardens, and Maintenance of Plants
- Role of Plants in Air pollution Control
- Introduction to Organic farming, Climate smart agriculture

Section B – Zoology
UNIT – III Animal Diversity and Human needs (8 Hours)
Animal diversity and importance in human life
Subtopics
- Types, Structure and Function of Animal Cell and its Components
- Animals and their ecosystem services (role of animals in pollination, seed dispersal, soil health, food security, domestic animals)
- Animal diversity in human environment: threats and conservation, human-animal conflict
- Economic importance and control of common household pests e.g. cockroach, housefly, mosquitoes and termites
- Identification and control of important stored grain pests
- Zoonotic disease: Transmission, Prevention and Control (Taeniasis, Ascariasis, Malaria, COVID-19, Bird flu, Rabies, Tuberculosis)

UNIT – IV Genetics, Immunity and Biotechnology (7 Hours)
Basics of genetics, birth defects, immunity and biotechnology
Subtopics
- Structure and Function of Genes and Chromosome
- Laws of Heredity and sex linked inheritance
- Case Studies: Inheritance of Thalassemia, Sickle Cell Anaemia and Phenylketonuria (PKU)
- Overview of Birth defects: Types and Causes with example like Down’s syndrome etc.
- Basics of Human Immunity
- Introduction to Biotechnology: Application in Animal Improvement and Medicines

Practical component – 30 Hours
SECTION A- BOTANY

1. Study the role of sunlight during photosynthesis
2. Study the rate of transpiration on both the surfaces of leaves
3. Assessment of soil quality: determination of soil pH, test for nitrates, nitrites
4. Preparation of soil mixture, potting and re-potting
5. Raising of healthy seedlings in a nursery bed
6. Propagation of plants through stem cutting , air layering and underground layering
7. Propagation of plants by approach grafting and veneer grafting
8. Identification and classification of economically important Food Crops, Medicinal, Fibre crops, Timber Plants and Oil Crops
9. Identification, care and maintenance of important plants in controlling air pollution
10. Preparation of temporary mount of onion peel

11. Preparation of temporary mount of epidermis of Rhoeo plant to study distribution of stomata on upper and lower surface of leave

SECTION B- ZOOLOGY

1. Study of cell structure through temporary slides: Blood Cells
2. Study of cell structure through temporary slides: Neurons
3. Study of cell cycle stages through permanent slides: Mitosis
4. Study of cell cycle stages through permanent slides: Meiosis
5. Identification of few common animal and birds in the human environment
6. Estimation of species richness and abundance of animal/ birds in the human environment using point count method
7. Estimation of species richness and abundance of animal/ birds in the human environment using transect method
8. Identification of life cycle stages of two common household pests: Termite and Mosquito
9. Methods of pest control and its application in houses (through audio/ visual/ seminar/visit)
10. Pedigree chart preparation & analysis
11. Demonstration of vermicomposting: preparation and monitoring of the setup at home
12. Case study of a zoonotic/ parasitic disease: COVID-19 pandemics/ bird flu

Essential readings

1. Jordan E. L. and Verma P. S. 2009. Invertebrate Zoology, S. Chand and Co. Ltd, New Delhi.
2. Raven P. and Johnson G. 2010. Biology. Tata McGraw Hill Publication, New Delhi.
3. Soni N. K. and Soni V. 2010. Fundamentals of Botany. Tata McGraw Hill Publication, New Delhi.
4. K. Park. 2016. Textbook of preventive and social medicine. Banarsidas Bhanot Publishers.
5. Singh J. S., Singh S. P. and Gupta S. R. 2017. Ecology, Environment Science and Resource Conservation. S.Chand (G/L) & Company Ltd, India.

Suggestive readings

1. Chadha K. L. 2012. Handbook of Horticulture. ICAR Publication, New Delhi.
2. Gopalaswamiianger K.S. 1991. Complete gardening in India. Messers Nagaraj and Co., Madras.
3. Magurran, A.E. 1988. Ecological Diversity and Measurement. Croom Helm Limited, Australia.
4. Gupta R. 2015. Fundamentals of Zoology: Theory and Practice. Elite Publishing House Pvt. Ltd., New Delhi.
5. Hartman H. T and Kester D. 1986. Plant Propagation: Principles and Practices Prentice Hall of India Pvt. Ltd., New Delhi.
6. Kotpal, R. L. 2000. Modern Textbook of Zoology. Rastogi Publications, Meerut.
7. Upadhyay R. 2017. Elements of Plant Science. Elite Publishing House, New Delhi.
8. Vij, U and Gupta, R. 2011. Applied Zoology. Phoenix Publishing House, New Delhi.

B.A (Prog.) with Nutrition and Health Education (NHE) as Major

Category-II

DISCIPLINE SPECIFIC CORE COURSE – DSC-1-NHE: FUNDAMENTALS OF NUTRITION

Credit distribution, Eligibility and Pre-requisites of the Course

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Prerequisite of the course
		Lecture	Tutorial	Practical/ Practice		
Fundamentals of Nutrition	4	3	1	-	Class XII Pass	NIL

Learning Objectives:
1. To familiarize students with fundamentals of nutrition and their relation to health.
2. To study the functions, dietary sources and clinical manifestations of deficiency or excess of nutrients.
3. To create awareness about enhancing nutritional quality of food.

Learning Outcomes:
After completion of the course, the students will be able to:
1. Understand basic concepts in nutrition and interpret relation between food, nutrition and health.
2. Describe functions, dietary sources and clinical manifestations of deficiency or excess of important nutrients.
3. Understand healthy cooking practices and minimizing nutrient losses.
4. Describe various methods of enhancing nutritional quality of food.

SYLLABUS OF DSC-1
Theory:

Unit 1: Basic Concepts in Nutrition (7 Hours)

- *Unit Description*: This unit will introduce the basic terms in nutrition
- *Subtopics:*
  - Basic terms used in study of nutrition – food, health, nutrients, nutritional status, malnutrition.
  - Macronutrients, micronutrients, nutraceuticals, phytochemicals, antioxidants and balanced diet.
  - Understanding relationship between food, nutrition and health.

Unit 2: Energy, Macronutrients and Water (13 Hours)

- *Unit Description:* This unit will introduce the students to energy components, macronutrients and water.
- *Subtopics:*
  - Energy- Components of energy expenditure and factors affecting energy requirement.

- Classification, functions, dietary sources and clinical manifestations of deficiency/excess of the following:
    - Carbohydrates including dietary fibre.
    - Dietary fat and fatty acids; introduction to lipoproteins (LDL & HDL)
    - Protein including protein quality

Unit 3: Micronutrients (18 Hours)

- *Unit Description:* This unit will introduce the various vitamins and minerals present in foods.
- *Subtopics:*
- Functions, dietary sources and clinical manifestations of deficiency /excess of the following:
    - Fat soluble vitamins – A, D, E and K.
    - Water soluble vitamins – thiamine, riboflavin, niacin, pyridoxine, folic acid, vitamin B_{12} and vitamin C.
    - Minerals – calcium, iron, iodine, zinc, sodium and potassium.

Unit 4: Enhancing Nutritional Quality of Food (7 Hours)

- *Unit Description*: This unit will explain ways to minimize nutrient losses and enhance nutritional quality of food
- *Subtopics:*
    - Minimizing nutrient losses during food preparation.
    - Enhancing nutritional quality by supplementation, germination, fermentation and fortification.

Essential/recommended readings:

1. Rekhi, T., & Yadav, H. (2015). *Fundamentals of Food and Nutrition.* Delhi: Elite Publishing House Pvt. Ltd.
2. Mudambi, S. R., & Rajagopal M. V. (2012). *Fundamentals of food, nutrition and diet therapy*; (6th ed.). Delhi: New Age International (P) Ltd.
3. Sethi, P., & Lakra, P. (2015). *Aahar Vigyan, Poshan Evam Suraksha*. Delhi: Elite Publishing House Pvt. Ltd.
4. Chadha, R., & Mathur, P. (2015). *Nutrition: A life cycle approach*. Delhi: Orient Blackswan.
5. Srilakshmi, B. (2018). *Food science* (7th ed.) Delhi: New Age International (P) Ltd.

Suggested readings:

1. Roday, S. (2013). *Food science and nutrition*. (2nd ed.). Oxford University Press.
2. Wardlow, G. M., & Hampl, J. S. (2019). *Perspectives in nutrition.* (11th ed.). New York, NY: McGraw Hill.
3. Agarwal, A., & Udipi. S. (2014). *Textbook of human nutrition*, Jaypee Brothers Medical Publishers (P) Ltd, New Delhi.

DISCIPLINE SPECIFIC CORE COURSE – DSC-2-NHE: INTRODUCTION TO FOODS

Credit distribution, Eligibility and Pre-requisites of the Course

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Prerequisite of the course
		Lecture	Tutorial	Practical/ Practice		
Introduction to Foods	4	3	-	1	Class XII Pass	NIL

Learning Objectives:

1. To introduce students with the functions of food.
2. To explain the nutritional contribution, selection, changes in cooking and storage of different food groups.
3. To generate awareness about various methods of cooking.

Learning Outcomes:

After completion of the course, the students will be able to:

1. Understand various functions of food and factors affecting food choices.
2. Acquaint themselves to select, purchase and store food safely.
3. Describe various methods of cooking and principles underlying them.

SYLLABUS OF DSC-2

Theory:

Unit 1: Basic Concepts of Food (8 Hours)

- *Unit Description:* This unit will introduce the concept of food, functions of food and factors affecting food choices.
- *Subtopics:*
    - Definition of food including organic food, genetically modified foods, convenience foods, health foods.
    - Functions of food.
    - Factors affecting food choices.

Unit 2: Plant Based Food Groups (15 Hours)

- *Unit Description:* This unit will introduce nutritional contribution, selection, changes in cooking and storage of the plant-based food groups.
- *Subtopics:*
    - Nutritional contribution, selection, changes in cooking and storage of the following:
        - Cereal and cereal products
        - Pulses
        - Vegetable and fruits
            - Sugars
            - Oils and fats

Unit 3: Animal Based Food Groups (8 Hours)

- *Unit Description:* This unit will introduce nutritional contribution, selection, changes in cooking and storage of the animal-based food groups.

- *Subtopics:*
    - Nutritional contribution, selection, changes in cooking and storage of the following:
        - Milk and milk products
        - Eggs and flesh foods

Unit 4: Methods of Cooking Foods **(14 Hours)**
- *Unit Description:* This unit will introduce advantages and principles of cooking and various cooking methods.
- *Subtopics:*
    - Advantages of cooking
    - Principles of cooking
    - Preliminary steps in food preparation
    - Cooking methods:
        - Moist heat methods
        - Dry heat methods
        - Methods using fat as a medium
        - Others – microwave, solar cooking

Practical:

Unit 1: Cooking methods I (16 Hours)
- *Subtopics:*
    - Cooking employing dry heat methods
    - Cooking employing moist heat methods

Unit 2: Cooking methods II **(14 Hours)**
- *Subtopics:*
    - Cooking using frying as a cooking method
    - Cooking using microwave

Essential/recommended readings:

1. Rekhi, T., & Yadav, H. (2015). *Fundamentals of Food and Nutrition.* Delhi: Elite Publishing House Pvt. Ltd.
2. Mudambi, S. R., & Rajagopal M. V. (2012). *Fundamentals of food, nutrition and diet therapy*; (6th ed.). Delhi: New Age International (P) Ltd.
3. Sethi, P., & Lakra, P. (2015). *Aahar Vigyan, Poshan Evam Suraksha*. Delhi: Elite Publishing House Pvt. Ltd.
4. Srilakshmi, B. (2018). *Food science* (7th ed.) Delhi: New Age International (P) Ltd.
5. Raina, U., & Kashyap, S. (2010). *Basic Food Preparation – a complete manual* (4th ed.). Delhi: Orient Black Swan.

Suggested readings:

1. Roday, S. (2013). *Food science and nutrition*. (2nd ed.). Oxford University Press.
2. Wardlow, G. M., & Hampl, J. S. (2019). *Perspectives in nutrition.* (11th ed.). New York, NY: McGraw Hill.
3. Agarwal, A., & Udipi. S. (2014). *Textbook of human nutrition*, Jaypee Brothers Medical Publishers (P) Ltd, New Delhi.
4. Chadha, R., & Mathur, P. (2015). *Nutrition: A life cycle approach*. Delhi: Orient Blackswan.

B.A (Prog.) with Nutrition and Health Education (NHE) as Non-Major

Category-III

DISCIPLINE SPECIFIC CORE COURSE – DSC-2-NHE: INTRODUCTION TO FOODS

Credit distribution, Eligibility and Pre-requisites of the Course

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Prerequisite of the course
		Lecture	Tutorial	Practical/ Practice		
Introduction to Foods	4	3	-	1	Class XII Pass	NIL

Learning Objectives:

1. To introduce students with the functions of food.
2. To explain the nutritional contribution, selection, changes in cooking and storage of different food groups.
3. To generate awareness about various methods of cooking.

Learning Outcomes:

After completion of the course, the students will be able to:

1. Understand various functions of food and factors affecting food choices.
2. Acquaint themselves to select, purchase and store food safely.
3. Describe various methods of cooking and principles underlying them.

SYLLABUS OF DSC-1

Theory:

Unit 1: Basic Concepts of Food (8 Hours)

- *Unit Description:* This unit will introduce the concept of food, functions of food and factors affecting food choices.
- *Subtopics:*
    - Definition of food including organic food, genetically modified foods, convenience foods, health foods.
    - Functions of food.
    - Factors affecting food choices.

Unit 2: Plant Based Food Groups (15 Hours)

- *Unit Description:* This unit will introduce nutritional contribution, selection, changes in cooking and storage of the plant-based food groups.
- *Subtopics:*
    - Nutritional contribution, selection, changes in cooking and storage of the following:
        - Cereal and cereal products
        - Pulses
        - Vegetable and fruits

        - Sugars
        - Oils and fats

Unit 3: Animal Based Food Groups (8 Hours)

- *Unit Description:* This unit will introduce nutritional contribution, selection, changes in cooking and storage of the animal-based food groups.
- *Subtopics:*
    - Nutritional contribution, selection, changes in cooking and storage of the following:
        - Milk and milk products
        - Eggs and flesh foods

Unit 4: Methods of Cooking Foods (14 Hours)

- *Unit Description:* This unit will introduce advantages and principles of cooking and various cooking methods.
- *Subtopics:*
    - Advantages of cooking
    - Principles of cooking
    - Preliminary steps in food preparation
    - Cooking methods:
        - Moist heat methods
        - Dry heat methods
        - Methods using fat as a medium
        - Others – microwave, solar cooking

Practical:

Unit 1: Cooking methods I (16 Hours)

- *Subtopics:*
    - Cooking employing dry heat methods
    - Cooking employing moist heat methods

Unit 2: Cooking methods II (14 Hours)

- *Subtopics:*
    - Cooking using frying as a cooking method
    - Cooking using microwave

Essential/recommended readings:

1. Rekhi, T., & Yadav, H. (2015). *Fundamentals of Food and Nutrition.* Delhi: Elite Publishing House Pvt. Ltd.
2. Mudambi, S. R., & Rajagopal M. V. (2012). *Fundamentals of food, nutrition and diet therapy*; (6th ed.). Delhi: New Age International (P) Ltd.
3. Sethi, P., & Lakra, P. (2015). *Aahar Vigyan, Poshan Evam Suraksha*. Delhi: Elite Publishing House Pvt. Ltd.
4. Srilakshmi, B. (2018). *Food science* (7th ed.) Delhi: New Age International (P) Ltd.
5. Raina, U., & Kashyap, S. (2010). *Basic Food Preparation – a complete manual* (4th ed.). Delhi: Orient Black Swan.

Suggested readings:

1. Roday, S. (2013). *Food science and nutrition*. (2nd ed.). Oxford University Press.
2. Wardlow, G. M., & Hampl, J. S. (2019). *Perspectives in nutrition.* (11th ed.). New York, NY: McGraw Hill.
3. Agarwal, A., & Udipi. S. (2014). *Textbook of human nutrition*, Jaypee Brothers Medical Publishers (P) Ltd, New Delhi.

4. Chadha, R., & Mathur, P. (2015). *Nutrition: A life cycle approach*. Delhi: Orient B lackswan.

B.A (Prog.) with Apparel Design and Construction (ADC) as Major

Category-II

DISCIPLINE SPECIFIC CORE COURSE – DSC-1-ADC: FUNDAMENTALS OF APPAREL DESIGN AND CONSTRUCTION

Credit Distribution, Eligibility and Pre-requisites of the Course

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Prerequisite of the course
		Lecture	Tutorial	Practical/ Practice		
Fundamentals of Apparel Design & Construction	4	2	-	2	Class XII Pass	NIL

Learning Objectives:

1. To familiarise the students with the terminologies and concepts related to apparel design and its construction
2. To provide the basic knowledge of the different tools and processes involved in garment design and construction
3. To familiarise the students with the concepts related to apparel finishes and quality
4. To provide an introduction to home and technical textiles

Learning Outcomes:

After completion of the course, the students will be able to:

1. Define basic apparel design and construction terminologies
2. Identify and describe the functions of tools used in garment design and pattern making
3. Describe the importance and types of fabric grain.
4. Explain the steps of garment construction such as the preparation of the fabrics, laying out the patterns, cutting and marking the fabrics
5. Explain different types of pattern layout on various fabrics.
6. Make different types of temporary, permanent and decorative stitches.
7. Finish plain seam using various techniques
8. Construct a flanged pillow cover and Petticoat
9. Identify and describe the types of home textiles and technical textiles

SYLLABUS OF DSC-1

Theory:

Unit 1: Introduction to Apparel Design (10 Hours)

- *Unit Description:* This unit introduces the students to common terminologies and concepts associated with garment design. It also deals with the aspects and factors affecting garment design and the type of trimmings that would add to the aesthetic aspects of the design.

- *Sub Topics:*

- Common terms: Apparel, Seam, Seam Finish, Seam allowance, Basic Blocks, Pattern, Grading, Stay stitching, Facing, Binding, Hem, Yoke, Gusset, Nap, Darts, Pleats, Tucks, Gathers
- Garment Design: Aspects (Function, Structure, Decoration) and types (Structural and Applied/Decorative), Application of structural and decorative design in a garment
- Trimmings – Types, selection and application of trimmings on apparels.
- Garment designing according to age, climate, occasion, occupation, fashion

Unit 2: Basics of Apparel Construction (10 Hours)

- *Unit Description:* This unit provides the basic knowledge of the tools and steps associated with apparel construction.

- *Sub Topics:*
  - Fabric grain – types, identification and importance in apparel construction
  - Common tools and equipment required for measuring, drafting, pinning, marking, cutting, sewing, pressing
  - Preparation of fabrics for clothing construction- Pre-shrinking, Grain straightening, truing
  - Steps in Clothing Construction – Pattern layout, pinning, marking, cutting and sewing
  - Pattern Layout - general guidelines, basic layouts- lengthwise, partial lengthwise, crosswise, double fold, open, combination fold

Unit 3: Application of Textiles and Garment Quality (10 Hours)

- *Unit Description:* This unit familiarises the students of the Application of textiles as apparel, at home and in the industry. It also introduces the students to the concept of readymade garment quality and the criteria for quality evaluation.

- *Sub Topics:*
  - Apparel/Garment Classification
  - Home Textiles – Categories, Standard Sizes and Fabrics used for Towels, Bed Linen
  - Technical Textiles – Medical textiles, Protective textiles, Sports textiles, Smart textiles
  - Garment Labels: Types and importance of labels with special reference to care labels
  - Evaluating the quality of readymade garments: overall appearance, fabric, fit, workmanship, finishing, price
  - Project work: Evaluation of Readymade garment Quality

Practical:

Unit 1: Hand Stitches and Basic Blocks (30 Hours)

- *Sub Topics:*
  - Hand Stitches
    1. Temporary hand stitches - even, uneven, pin, machine, diagonal basting, thread mark
    2. Permanent hand stitches - hemming, blind hemming, back stitch, fine stitch
    3. Decorative hand stitches – stem, chain, herringbone, running, lazy-daisy, satin
    4. Fastener attachment – Button and buttonhole, Hook and eye, Press Button
  - Child's basic bodice and basic sleeve block.
  - Adaptation of child's basic sleeve to flared, puffed sleeve

Unit 2: Machine Sewing and Design Analysis **(30 Hours)**

- *Sub Topics:*
    - Introduction to sewing machine - Practice of running sewing machine on paper and fabric on straight lines, curved lines and corners.
    - Plain seam and seam finishes - Pinking, Turned and Stitched, Edge stitched, hand overcast, over-locked, Piped/Bound
    - Samples of pleats, tucks, gathers
    - Construction of a flanged pillow cover, petticoat
    - Analysis of the use of structural and Decorative designs in garments.

Essential/ Recommended Readings:

- Colton V. (1995). Reader's Digest- Complete Guide to Sewing. New York: The Reader's Digest Association, Inc.
- Brown, P. and Rice, J.1998, Ready-to-wear Apparel Analysis, Prentice Hall,Frings G. (1996). Fashion-From Concept to Consumer (5th Edition). USA: Prentice Hall Publications
- Kallal, M. J., 1985, Clothing Construction, Macmillion Publishing Company, New York,
- Marshall S G, et al. (2009). Individuality in Clothing & Personal Appearance (6th Edition). USA: Pearson Education,
- Vanderhoff M., Franck L., Campbell L., (1985). Textiles for Homes and People. Massachusetts: Ginn and Company.

Suggested Readings:

- Cunningham G. (1976). Singer Sewing Book. New York: The Singer Company.
- Gayatri V. (2007). Cutting and Stitching Practical. New Delhi: Asian Publishers.
- Stamper, A.A., S. H. Sharp and L.B. Donnell, 1986, Evaluating Apparel Quality, Fairchild Publications, America
- Verma P. (2003). Vastra Vigyan Evam Paridhan. Bhopal: Hindi Granth Academy

DISCIPLINE SPECIFIC CORE COURSE – DSC-2-ADC: UNDERSTANDING FABRICS

Credit Distribution, Eligibility and Pre-requisites of the Course

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Prerequisite of the course
		Lecture	Tutorial	Practical/ Practice		
Understanding Fabrics	4	3	-	1	Class XII Pass	NIL

Learning Objectives:

1. To impart knowledge regarding production, properties and usage of textile fibres and yarns
2. To apprise the learners about the various techniques of fabric production and their properties
3. To familiarise the students with the concepts related to fabric finishes and quality.

Learning Outcomes:

After completion of the course, the students will be able to:

1. Classify textile fibres based on length and origin.
2. Identify different types of textile fibres using various tests.

3. Compare and select fabrics for different end uses based on their properties
4. Describe the properties of textile yarns based on their characteristics
5. Identify different textile fabrics based on their construction
6. Refer to fabrics by their popular trade names and their characteristics
7. Select fabrics for different end uses based on their regular and functional finishes
8. Describe the desirable fabric properties for garment construction
9. Inspect the fabrics and identify the quality related problems.

SYLLABUS OF DSC-2

Theory:

Unit 1: Textile Fibres **(10 Hours)**

- *Unit Description:* This unit provides basic knowledge of textile fibres to create a better understanding of the properties and end use of the fabrics made from different fibres

- *Sub Topics:*
  - Textile Fibre classification based on their Origin (natural and man-made) and Length (staple and filament)
  - Identification of textile fibres through Physical examination (Visual and Feeling test), Burning test, Microscopic test, Chemical test
  - Natural and Manmade Fibres - Properties and end-uses (Cotton, Linen, Wool, Silk, Rayon, Acetate, Nylon, Polyester, Acrylic, Spandex)
  - Newer Fibres – Properties and end uses

Unit 2: Textile Yarns **(10 Hours)**

- *Unit Description:* This unit provides basic knowledge of the yarn making processes and yarn properties to create a better understanding the fabrics made from them.

- *Sub Topics:*
  - Yarn manufacturing process – Basic steps of Mechanical and chemical spinning
  - Types of yarn – Spun and Filament, Simple and Fancy/Novelty
  - Yarn properties – Yarn count, Yarn twist

Unit 3: Fabric Construction **(15 Hours)**

- *Unit Description:* This unit provides knowledge of the most common fabric construction methods to help understand the properties of the fabrics better. It also deals with the quality aspects of the fabric and the procedures for checking their required quality specifications.

- *Sub Topics:*
  - Fabric construction methods – weaving, knitting, lace, net, felt and non-woven, braiding – properties and end uses
  - Weaving : Basic loom - parts and operations
  - Basic and fancy weaves – plain, twill, satin, dobby, jacquard, pile, leno, surface figure weaves
  - Knitting: Basic Construction, Characteristics and usage
  - Blended fabrics – Reasons for blending, Properties of common Blended Fabrics

- Glossary of Common Fabrics
- Fabric characteristics - texture, hand, weight, width
- Fabric Quality -Fabric inspection systems, Common Fabric defects, Acceptable quality level
- Visit to Weavers' Service Facility and writing a report on the visit

Unit 4: Fabric Finishes **(10 Hours)**

- *Unit Description:* This unit deals with the common routine and functional finishes applied on fabrics to provide a better understanding of fabric performance properties.

- *Sub Topics*:
  - Aims and classification of Fabric finishes
  - Basic/ Routine finishes - Scouring, Bleaching, De-sizing, Singeing, Mercerisation, Tentering, Calendaring
  - Functional finishes - Crease resistant, flame retardant, Anti-microbial, moth proofing

Practical:

Unit 1: Identification of Fibres and Yarns **(10 Hours)**

- *Subtopics:*
  - Identification of fibres – Physical Examination, Burning Test, Demonstration of Chemical and Microscopic Test
  - Identification of yarns by visual examination – spun & filament yarns, ply & novelty yarns

Unit 2: Analysis of Fabric Properties **(20 Hours)**
- *Subtopics:*
  - Analysis of Fabric properties - Dimensional Stability, Thread Count, GSM
  - Calculation of Yarn Count
  - Preparation of samples of basic weaves through paper/ribbon weaving
  - Preparation of a file containing fabric swatches of various Fibres, Yarns, Fabrics, Weaves, Fabric defects.

Essential Readings:

1. Corbman P.B. (1985). Textiles-Fibre to Fabric. New York: McGraw Hill Book Co.
2. Grover E. B. & Hamby D. S., (1969), Handbook of textile testing and quality control, New Delhi: Wiley Eastern Ltd. Handbook of textile testing,
3. Rastogi, D. & Chopra, S. (Eds.) (2017). Textile Science. New Delhi, India: Orient Black Swan Publishing Limited.
4. Sekhri S. (2013). Textbook of Fabric Science: Fundamentals to Finishing. Delhi, India: PHI Learning.

Suggested Readings:

1. Allec C., Johnson I., Joseph P. (2011). Fabric Science (6th Edition). New York: Fairchild Publications.
2. Bureau of Indian standards, (1990), Testing and grading of textile fibers, Part I-III, New Delhi
3. Tortora (1992) Understanding Textiles. 4th Ed., New York Macmillan Publishing Company
4. Verma P. (2003). Vastra Vigyan Evam Paridhan. Bhopal: Hindi Granth Academy.

B.A (Prog.) with Apparel Design and Construction (ADC) as Non-Major

Category-III

DISCIPLINE SPECIFIC CORE COURSE – DSC-2-ADC: UNDERSTANDING FABRICS

Credit Distribution, Eligibility and Pre-requisites of the Course

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Prerequisite of the course
		Lecture	Tutorial	Practical/ Practice		
Understanding Fabrics	4	3	-	1	Class XII Pass	NIL

Learning Objectives:

1. To impart knowledge regarding production, properties and usage of textile fibres and yarns
2. To apprise the learners about the various techniques of fabric production and their properties
3. To familiarise the students with the concepts related to fabric finishes and quality.

Learning Outcomes:

After completion of the course, the students will be able to:

1. Classify textile fibres based on length and origin.
2. Identify different types of textile fibres using various tests.
3. Compare and select fabrics for different end uses based on their properties
4. Describe the properties of textile yarns based on their characteristics
5. Identify different textile fabrics based on their construction
6. Refer to fabrics by their popular trade names and their characteristics
7. Select fabrics for different end uses based on their regular and functional finishes
8. Describe the desirable fabric properties for garment construction
9. Inspect the fabrics and identify the quality related problems.

SYLLABUS OF DSC-1A

Theory:

Unit 1: Textile Fibres **(10 Hours)**

- *Unit Description:* This unit provides basic knowledge of textile fibres to create a better understanding of the properties and end use of the fabrics made from different fibres

- *Sub Topics:*
    - Textile Fibre classification based on their Origin (natural and man-made) and Length (staple and filament)
    - Identification of textile fibres through Physical examination (Visual and Feeling test), Burning test, Microscopic test, Chemical test
    - Natural and Manmade Fibres - Properties and end-uses (Cotton, Linen, Wool, Silk, Rayon, Acetate, Nylon, Polyester, Acrylic, Spandex)
    - Newer Fibres – Properties and end uses

Unit 2: Textile Yarns **(10 Hours)**

- *Unit Description:* This unit provides basic knowledge of the yarn making processes and yarn properties to create a better understanding the fabrics made from them.

- *Sub Topics:*
    - Yarn manufacturing process – Basic steps of Mechanical and chemical spinning
    - Types of yarn – Spun and Filament, Simple and Fancy/Novelty
    - Yarn properties – Yarn count, Yarn twist

Unit 3: Fabric Construction **(15 Hours)**

- *Unit Description:* This unit provides knowledge of the most common fabric construction methods to help understand the properties of the fabrics better. It also deals with the quality aspects of the fabric and the procedures for checking their required quality specifications.

- *Sub Topics:*
    - Fabric construction methods – weaving, knitting, lace, net, felt and non-woven, braiding – properties and end uses
    - Weaving : Basic loom - parts and operations
    - Basic and fancy weaves – plain, twill, satin, dobby, jacquard, pile, leno, surface figure weaves
    - Knitting: Basic Construction, Characteristics and usage
    - Blended fabrics – Reasons for blending, Properties of common Blended Fabrics
    - Glossary of Common Fabrics
    - Fabric characteristics - texture, hand, weight, width
    - Fabric Quality -Fabric inspection systems, Common Fabric defects, Acceptable quality level
    - Visit to Weavers' Service Facility and writing a report on the visit

Unit 4: Fabric Finishes **(10 Hours)**

- *Unit Description:* This unit deals with the common routine and functional finishes applied on fabrics to provide a better understanding of fabric performance properties.

- *Sub Topics*:
    - Aims and classification of Fabric finishes
    - Basic/ Routine finishes - Scouring, Bleaching, De-sizing, Singeing, Mercerisation, Tentering, Calendaring
    - Functional finishes - Crease resistant, flame retardant, Anti-microbial, moth proofing

Practical:

Unit 1: Identification of Fibres and Yarns **(10 Hours)**

- *Subtopics:*
    - Identification of fibres – Physical Examination, Burning Test, Demonstration of Chemical and Microscopic Test
    - Identification of yarns by visual examination – spun & filament yarns, ply & novelty yarns

Unit 2: Analysis of Fabric Properties **(20 Hours)**

- *Subtopics:*
    - Analysis of Fabric properties - Dimensional Stability, Thread Count, GSM
    - Calculation of Yarn Count
    - Preparation of samples of basic weaves through paper/ribbon weaving
    - Preparation of a file containing fabric swatches of various Fibres, Yarns, Fabrics, Weaves, Fabric defects.

Essential Readings:

1. Corbman P.B. (1985). Textiles-Fibre to Fabric. New York: McGraw Hill Book Co.
2. Grover E. B. & Hamby D. S., (1969), Handbook of textile testing and quality control, New Delhi: Wiley Eastern Ltd. Handbook of textile testing,
3. Rastogi, D. & Chopra, S. (Eds.) (2017). Textile Science. New Delhi, India: Orient Black Swan Publishing Limited.
4. Sekhri S. (2013). Textbook of Fabric Science: Fundamentals to Finishing. Delhi, India: PHI Learning.

Suggested Readings:

1. Allec C., Johnson I., Joseph P. (2011). Fabric Science (6th Edition). New York: Fairchild Publications.
2. Bureau of Indian standards, (1990), Testing and grading of textile fibers, Part I-III, New Delhi
3. Tortora (1992) Understanding Textiles. 4th Ed., New York Macmillan Publishing Company
4. Verma P. (2003). Vastra Vigyan Evam Paridhan. Bhopal: Hindi Granth Academy.

B.A (Prog.) with Human Development and Family Empowerment (HDFE) as Major

Category-II

DISCIPLINE SPECIFIC CORE COURSE – DSC-1-HDFE: THEORETICAL FOUNDATIONS IN HUMAN DEVELOPMENT

Credit distribution, Eligibility and Pre-requisite of the Course

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Prerequisite of the course
		Lecture	Tutorial	Practical/ Practice		
Theoretical Foundations in Human Development	4	3	-	1	Class XII Pass	NIL

Learning Objectives:
1. To enable an understanding of the significance of the theoretical basis of Human Development.
2. To gain an in-depth understanding of selected theories in Human Development.

Learning Outcomes:

After completing this course, the students will be able to:

1. Gain an insight into the importance and role of theories in Human Development.
2. Develop an understanding of selected theories in Human Development.
3. Become aware of the concepts and perspectives related to Human Development.

THEORY
(Credits: 3, Periods: 45)

Unit I: Introduction to theories in Human Development (6 hours)

- *Unit Description:* The unit will introduce themes in the area of human development covering nature/nurture, heredity/environment, continuity/discontinuity, individual differences and similarities.
- *Subtopics:*
  - Key themes in the study of Human Development- Nature/nurture, heredity/environment, continuity/discontinuity, individual differences and similarities.

Unit II: Psycho-analytic perspectives on Human Development (13 hours)

- *Unit Description*: The unit will introduce the Psycho-analytical perspectives on Human Development by Sigmund Freud and Eric H. Erikson.
- *Subtopics:*
  - Psycho-sexual theory by Sigmund Freud

- o Psycho-social theory by Eric H. Erikson

Unit III: Theories on Cognitive Development (13 hours)

- *Unit Description:* The unit will introduce the theoretical perspective with regard to cognitive development. This unit will be covering theories by Jean Piaget and Lev Vygotsky.
- *Subtopics:*
  - o Theory of Cognitive Development by Jean Piaget
  - o Socio-cultural theory of Cognitive Development by Lev Vygotsky

Unit IV: Selected Theories in Child Development (13 hours)

- *Unit Description:* The unit will introduce theories in the area of child development. This unit will be covering theories by Urie Bronfenbrenner, Albert Bandura, John Bowlby and so on.
- *Subtopics:*
  - o Ecological Systems Theory by Urie Bronfenbrenner
  - o Social Learning Theory by Albert Bandura
  - o Attachment Theories (John Bowlby, Mary Ainsworth, Harry Harlow)

PRACTICAL
(Credit: 1; Periods: 30)

- o **Unit 1: Biography of any one theorist of human development (15 hours)**
- o **Unit 2: Application of any one theory in real life situations (15 hours)**

Essential / recommended readings:

1. Newman, P.R., & Newman, B.M. (2015). Theories of Human Development. New York: Routledge
2. Rice, P. (2000). Human Development: A Lifespan Approach (4th edition). (and all further editions). New Jersey, Prentice-Hall Inc
3. Srivastava, V.N., Srivastava D.N. (2020). *Adhunik vikasatmak manovigyan.* Shi Vinod Pustak Mandir.
4. Allen, B.P. (2006). Personality theories: Development, growth and diversity (5th ed.) Needham Heights, MA: Allyn and Bacon

Suggested Readings:

1. Berk, L. E. (2000). Child development. New Delhi: Prentice Hall.
2. Berk, L. E. (2017). Exploring Lifespan Development. New York: Pearson
3. Berger, J.M. (2010). Personality (8th ed.). Belmont, CA: Thomson/Wadswort. Journal of Developmental Psychology
4. Santrock, J.W. (2007). Lifespan Development (3rd ed.). New Delhi, Tata- McGraw Hill

DISCIPLINE SPECIFIC CORE COURSE – DSC-2-HDFE: PRINCIPLES OF CHILD DEVELOPMENT

Credit distribution, Eligibility and Pre-requisite of the Course

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Prerequisite of the course
		Lecture	Tutorial	Practical / Practice		
Principles of Child Development	4	3	--	1	Class XII Pass	Nil

Learning Objectives:

1. To familiarize students with the concept of child development as a field of study.
2. To introduce students with various methods of child study
3. To create an understanding of prenatal development

Learning Outcomes:

After completing this course, the students will be able to:

1. Get familiarized with the concept of child development as a field of study.
2. Develop an understanding of prenatal development.
3. Learn about the basics of techniques of data collection.

THEORY
(Credits:3, Periods: 45)

Unit I: Introduction to Child Development (10 hours)

- *Unit Description:* This unit will introduce child development as a field of study. It also will provide insights into the historical perspective regarding development of children.
- *Subtopics:*
    - Definition, Scope and importance of child development as a field of study
    - Historical foundation of child development

Unit II: Introduction to methods of Child Study (11 hours)

- *Unit Description:* The unit will introduce the methods of child study through the examples of well framed interviews, questionnaires.
- *Subtopics:*
    - Observation
    - Interview
    - Questionnaire
    - Case study

Unit III: Aspects of Development (11 hours)

- *Unit Description:* The unit will introduce about the aspects of development through discussion on the principles of development, developmental norms.
- *Subtopics:*

- Principles of Development
- Developmental Norms

Unit IV: Prenatal Development (13 hours)

- *Unit Description:* The unit will introduce prenatal development through presentations on stages of prenatal development and factors which have an impact.
- Subtopics:
  - Stages of prenatal development
  - Factors affecting prenatal development

PRACTICAL

(Credit:1, Periods:30)

Unit I: Recording/documenting any two methods of data collection (20 hours)

Unit 2: Review of any one documentary related to prenatal development (10 hours)

Essential / recommended readings:

1. Berk, L. E. (2013). *Child development (9th edition*). New Delhi: Prentice Hall.
2. Colley, D. and Cooper, P. (Eds.) (2017). *Attachment and emotional development in the classroom*. Oxford City: Jessica Kingley Publishers
3. Verma, P., Srivastava, D. N. and Singh, A. (1996). *Bal manovigyan and bal vikas*. Agra: Agrawal Publication.
4. Singh, A. (2015). *Foundation of human development: a lifespan approach*. Hyderabad: Orient Longman.

Suggested Readings:

1. Bee, H. L. (2011). *The developing child*. London: Pearson.
2. Papilla, D.E., Olds, S. W. and Feldman, R. D. (2004). *Human development*. New York: Mcgraw Hill.
3. Singh, A. (2015). *Foundation of human development: a lifespan approach*. Hyderabad: Orient Longman.
4. Singh, V. (2007). *Bal vikas avam bal manovigyan*. Jaipur: Panchsheel Prakashan.

B.A (Prog.) with Human Development and Family Empowerment (HDFE)

as Non-Major

Category-III

DISCIPLINE SPECIFIC CORE COURSE – DSC-2-HDFE: PRINCIPLES OF CHILD DEVELOPMENT

Credit distribution, Eligibility and Pre-requisite of the Course

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Prerequisite of the course
		Lecture	Tutorial	Practical / Practice		
Principles of Child Development	4	3	--	1	Class XII Pass	Nil

Learning Objectives:

1. To familiarize students with the concept of child development as a field of study.
2. To introduce students with various methods of child study
3. To create an understanding of prenatal development

Learning Outcomes:

After completing this course, the students will be able to:

4. Get familiarized with the concept of child development as a field of study.
5. Develop an understanding of prenatal development.
6. Learn about the basics of techniques of data collection.

THEORY
(Credits:3, Periods: 45)

Unit I: Introduction to Child Development (10 hours)

- *Unit Description:* This unit will introduce child development as a field of study. It also will provide insights into the historical perspective regarding development of children.
- *Subtopics:*
  - Definition, Scope and importance of child development as a field of study
  - Historical foundation of child development

Unit II: Introduction to methods of Child Study (11 hours)

- *Unit Description:* The unit will introduce the methods of child study through the examples of well framed interviews, questionnaires.
- *Subtopics:*
  - Observation
  - Interview

- Questionnaire
- Case study

Unit III: Aspects of Development **(11 hours)**

- *Unit Description:* The unit will introduce about the aspects of development through discussion on the principles of development, developmental norms.
- *Subtopics:*
  - Principles of Development
  - Developmental Norms

Unit IV: Prenatal Development **(13 hours)**

- *Unit Description:* The unit will introduce prenatal development through presentations on stages of prenatal development and factors which have an impact.
- Subtopics:
  - Stages of prenatal development
  - Factors affecting prenatal development

PRACTICAL

(Credit:1, Periods:30)

Unit I: Recording/documenting any two methods of data collection **(20 hours)**

Unit 2: Review of any one documentary related to prenatal development **(10 hours)**

Essential / recommended readings:

1. Berk, L. E. (2013). *Child development (9th edition*). New Delhi: Prentice Hall.
2. Colley, D. and Cooper, P. (Eds.) (2017). *Attachment and emotional development in the classroom*. Oxford City: Jessica Kingley Publishers
3. Verma, P., Srivastava, D. N. and Singh, A. (1996). *Bal manovigyan and bal vikas*. Agra: Agrawal Publication.
4. Singh, A. (2015). *Foundation of human development: a lifespan approach*. Hyderabad: Orient Longman.

Suggested readings:

1. Bee, H. L. (2011). *The developing child*. London: Pearson.
2. Papilla, D.E., Olds, S. W. and Feldman, R. D. (2004). *Human development*. New York: Mcgraw Hill.
3. Singh, A. (2015). *Foundation of human development: a lifespan approach*. Hyderabad: Orient Longman.
4. Singh, V. (2007). *Bal vikas avam bal manovigyan*. Jaipur: Panchsheel Prakashan.

B.A. (Prog.) with Food Technology (FT) as Major
Category-II

DISCIPLINE SPECIFIC CORE COURSE – DSC-1-FT: BASICS IN FOOD AND NUTRITION

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Basics in Food and Nutrition	4	3	0	1	Class XII Pass	NIL

LEARNING OBJECTIVES:

1. To familiarize students with the relationship between food, nutrition, nutrients and health
2. To describe the functions, sources, deficiencies and excess of various nutrients
3. To make students understand the principles and methods of conserving and enhancing nutrients during cooking food
4. Prepare dishes using basic principles of food science and nutrition.

LEARNING OUTCOMES:

After completion of the course, the students will be able to:

1. Understand the basic concepts related to of the vibrant field of nutrition
2. Gain theoretical and practical knowledge about balanced diet, energy, macro nutrients and micro-nutrients
3. Judiciously adopt healthier methods of cooking based on the available resources
4. Adopt methods of processing food which would help to conserving/ enhancing nutrients while processing food.

SYLLABUS OF DSC-1-FT

THEORY:

UNIT I: Basic Concepts and Introduction to Food and Nutrition (5 Hours)

- *Unit Description:* This unit will introduce the vibrant field of nutrition to the students. They will be appraised about the relationship of food with health and basics of a balanced diet.

- *Subtopics:*
    - Basic terms in food, nutrition and health
    - Functions of food
    - Foods groups
    - Balanced diet

UNIT II: Energy and Macronutrients (12 Hours)

- *Unit Description:* The students will learn about the concepts of energy in food and its role in maintain good health. They will also learn about the energy giving macronutrients.
- *Subtopics:*
    - Energy: definition and units of measurement, factors affecting energy requirements, energy density of foods, energybalance.
    - Macronutrients: Functions, dietary sources and clinical manifestations of deficiency/ excess of carbohydrates, lipids and proteins.

UNIT III: Micronutrients (16 Hours)

- *Unit Description:* This unit will help students to learn about the role of micronutrients in maintaining good health, effects of deficient and high intake, food sources.
- *Subtopics:*
    - Functions, dietary sources and clinical manifestations of deficiency/ excess of the following nutrients:
    - Fat soluble vitamins-A, D, E and K
    - Water soluble vitamins – thiamine, riboflavin, niacin, pyridoxine, folate, vitamin B12 and vitamin C
    - Minerals – calcium, iron, zinc and iodine

Unit IV: Theory of Cooking and Enhancing Nutrients (12 Hours)

- *Unit Description:* The basic principles/methods of cooking food and ways of enhancing, conserving nutrients while cooking or processing food.
- *Subtopics:*
    - Methods of cooking food: dry heat, moist heat and combination
    - Methods of conserving nutrients
    - Methods of enhancing the nutritional quality of foods - supplementation, germination, fermentation, fortification and genetic modification of foods

PRACTICAL:

No. of Students per Practical Class Group: 10-15

	(2 Hours)
1. Prepare educational aid on balanced diet or food groups	
2. Preparing market order, selection of raw material	(2 Hours)
3. Weights and measures	(2 Hours)
4. Identification of presence/absence of food groups in given samples of food products/dishes/snacks available in college canteen	(2 Hours)
5. Estimation of Edible portion size (peas/cauliflower/bottle gourd, potato, green leafy vegetables, one seasonal fruit)	(2 Hours)
6. Pre-preparation Methods I: Washing, Peeling, Cutting, Chopping, Grating	(2 Hours)
7. Pre-preparation methods II: blanching, kneading, whipping, whisking	(2 Hours)
8. Dry-heat methods of cooking like roasting, grilling, frying	(2 Hours)
9. Moist-heat methods of cooking like steaming, boiling, pressure cooking	(2 Hours)
10. Planning and preparation of energy rich snack/dish.	(3 Hours)
11. Planning and preparation of protein rich snack/dish.	(3 Hours)
12. Planning and preparation of micronutrient (Vitamin A, Vitamin C) rich snack/dish.	(3 Hours)
13. Planning and preparation of micronutrient (Calcium, iron) rich snack/dish	(3 Hours)

ESSENTIAL/ RECOMMENDED READINGS (Theory and Practical):

1. Suri, S. and Malhotra, A. (2014). *Food Science Nutrition and Safety*. Delhi: Pearson India Ltd. Online Question Bank and student E Resources:https://wps.pearsoned.co.in/suri_fsns_1/Online Instructor Resources: www.pearsoned.co.in/sukhneetsuri
2. Sethi P, Lakra P.(2015). *Aahar Vigyan, poshan evam Suraksha* (Hindi);(2015).First Ed; 2015; Delhi: Elite Publishing House (P)Ltd.
3. Srilakshmi B (2018). Food Science, 7th Edition. Delhi: New Age International Ltd.
4. Khanna K, Gupta S, Seth R, Mahna R, Rekhi T. (2004). *The Art and Science of Cooking: A Practical Manual,* Revised Edition. New Delhi: Elite Publishing House PvtLtd.

SUGGESTED READINGS:

1. Bamji MS, Krishnaswamy K, Brahmam GNV (2016). *Textbook of Human Nutrition*, 4th edition. New Delhi: Oxford and IBH Publishing Co. Pvt. Ltd.
2. Chadha R and Mathur P (2015). *Nutrition: A Lifecycle Approach*. Hyderabad: Orient BlackSwan.
3. Roday, S (2018). *Food Science and Nutrition.* UK: Oxford UniversityPress.
4. Lanham, SA, Hill, TR, Gallagher, AM, Vorster, HH. (2019). Introduction to Human Nutrition, Third Nutrition, Wiley Blackwell, USA.
5. Whitney, E.N., Rolfes, S.R. (2016). *Understanding Nutrition*. 14th Edition; USA: Elsevier.
6. Pike, R.L. and Brown, M.L. (1984) An Integrated Approach. Nutrition, John Wiley& Sons, Hoboken,197.
7. Swaminathan, M. (2021). Advanced Textbook on Food and Nutrition. Banagalore Press.
8. Desai. (2019). Handbook of Nutrition and Diet. CRC Pres

DISCIPLINE SPECIFIC CORE COURSE – DSC-2-FT: FOOD SCIENCE PART-I

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Food Science Part-I	4	3	0	1	Class XII Pass	NIL

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LEARNING OBJECTIVES:

1. To introduce the students to the vibrant field of food science and food technology
2. To impart theoretical and practical knowledge about composition, nutritive value and processing of cereals, pulses, fruits, vegetables and meat.
3. To familiarize students with basics of food adulteration.

LEARNING OUTCOMES:

After completion of the course, the students will be able to:

1. Define food science and describe its association with other related fields; and understand the role of food science in food and health industry.
2. Describe composition, nutritive value and processing of cereals, pulses, fruits, Vegetables, meat, fish and poultry.
3. Justify scientifically the changes occurring in food during processing, handling and Storage. Describe enzymatic and non-enzymatic browning reactions in various foods.
4. Describe harmful effects of adulteration on health and will be able to detect presence of common adulterants in food.

THEORY:

UNIT I: Introduction to Food Science and Technology (15 Hours)

- *Unit Description:* This unit will introduce the students to the field of Food Science and Technology. It will also give information on basics of nutrition and food adulteration.
- *Subtopics:*
  - Definition, scope and current trends in food science and technology.
  - Basic introduction to macro and micronutrients-classification

and functions of various nutrients
  - o Definitions- food, safe food, nutrient, nutrition, balanced diet
  - o Commonly found food adulterants and their effect on health

UNIT II: Cereals and Pulses (10 Hours)

- *Unit Description:* The unit will focus on various aspects of composition, nutritive value and processing of cereals, millets and pulses.
- *Subtopics:*
  - o Composition and nutritive value, types of cereals and millets
  - o Gelatinization of starch and the factors affecting it, dextrinization, germination and fermentation
  - o Toxic constituents in pulses.

UNIT III: Fruits and Vegetables (12 Hours)

- *Unit Description:* The unit is about composition, nutritive value and processing aspects fruits and vegetables. It also describes about various browning reactions that take place during food processing.
- *Subtopics:*
  - o Classification of fruits and vegetables, composition and nutritive value; effect of processing on pigments.
  - o Browning Reactions- enzymatic & non-enzymatic, role in food preparation and prevention of undesirable browning.

UNIT IV: Meat, Fish and Poultry (8 Hours)

- *Unit Description:* The unit will focus on composition, nutritive value and processing aspects of meat, fish and poultry.
- *Subtopics:*
  - o Composition and nutritive value
  - o Types of meat, fish and poultry and their selection/purchasing criteria Rigor mortis, Tenderization and Curing.

PRACTICAL:

No. of Students per Practical Class Group: 10-15

1. Weights and Measures. (2 Hours)
2. Detection of adulterants in food (2 Hours)
3. Gelatinization of starch and the factors affecting it. (2 Hours)
4. Preparation of dish using gelatinization of starch (2 Hours)
5. Dextrinization of starch and its application (2 Hours)
6. Germination of pulses and cereals (2 Hours)
7. Preparation of products using sprouts (2 Hours)
8. Fermentation of cereals and pulses (2 Hours)
9. Preparation of cereal-pulse fermented products (2 Hours)
10. Effect of heat, acid and alkali on water soluble plant pigments. (2 Hours)
11. Effect of heat, acid and alkali on fat soluble plant pigments. (2 Hours)
12. Maillard browning during food preparation. (2 Hours)
13. Enzymatic browning and its prevention. (3 Hours)
14. Caramelization reaction in food. (2 Hours)

ESSENTIAL/ RECOMMENDED READINGS (Theory and Practical):

1. Sethi, P. &Lakra, P. (2015). Aahar Vigyan, Poshan Evam Suraksha. Delhi: Elite Publishing House Pvt.Ltd.
2. Srilakshmi, B. (2012). Food Science. Delhi: New Age International Pvt. Ltd.
3. Suri, S. & Malhotra, A. (2014). Food Science Nutrition and Safety. Delhi: Pearson India Ltd.
    i. Online Question Bank and student E Resources: https://wps.pearsoned.co.in/suri_fsns_1/Online Instructor Resources: www.pearsoned.co.in/sukhneetsuri
4. Potter,N., & Hotchkiss,J.H.(2007). FoodScience.5thEdition.Delhi:CBSPublishers.

5. Rekhi,, T. & Yadav, H. (2014). *Fundamentals of Food and Nutrition.* Delhi: Elite Publishing House Pvt. Ltd.

SUGGESTED READINGS:

1. Avantina S (2019). Textbook of Food Science and Technology, 3rd Edition, CBS Publishers and Distributors Pvt Limited

2. McWilliams, M. (2016). Foods: Experimental Perspectives. USA: Pearson.
3. Reddy,S.M. (2015).Basic Food Science and Technology. Delhi: New Age International Publishers.
4. Vaclavik, V.A. & Elizabeth, C. (2014). Essentials of Food Science. 4th Edition. New York: Springer.
5. Roday, S. (2018). *Food Science and Nutrition.* 3rd Edition. Delhi: Oxford University Press.
6. Geoffrey Campbell–Platt. Food Science and Technology. 1st edition (2009). Wiley–Blackwell
7. Sharma A. Textbook of Food Science and Technology 3rd Ed., (2022). CBS Publiher 9789386478009

B.A. (Prog.) with Food Technology (FT) as Non-Major
Category-III

DISCIPLINE SPECIFIC CORE COURSE – DSC-2-FT: FOOD SCIENCE PART-I

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Food Science Part-I	4	3	0	1	Class XII Pass	NIL

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LEARNING OBJECTIVES:

1. To introduce the students to the vibrant field of food science and food technology
2. To impart theoretical and practical knowledge about composition, nutritive value and processing of cereals, pulses, fruits, vegetables and meat.
3. To familiarize students with basics of food adulteration.

LEARNING OUTCOMES:

After completion of the course, the students will be able to:

1. Define food science and describe its association with other related fields; and understand the role of food science in food and health industry.
2. Describe composition, nutritive value and processing of cereals, pulses, fruits, Vegetables, meat, fish and poultry.
3. Justify scientifically the changes occurring in food during processing, handling and Storage. Describe enzymatic and non-enzymatic browning reactions in various foods.
4. Describe harmful effects of adulteration on health and will be able to detect presence of common adulterants in food.

THEORY:

UNIT I: Introduction to Food Science and Technology (15 Hours)

- *Unit Description:* This unit will introduce the students to the field of Food Science and Technology. It will also give information on basics of nutrition and food adulteration.

- *Subtopics:*
  - Definition, scope and current trends in food science and technology.
  - Basic introduction to macro and micronutrients-classification and functions of various nutrients
  - Definitions- food, safe food, nutrient, nutrition, balanced diet
  - Commonly found food adulterants and their effect on health

UNIT II: Cereals and Pulses **(10 Hours)**

- *Unit Description:* The unit will focus on various aspects of composition, nutritive value and processing of cereals, millets and pulses.
- *Subtopics:*
  - Composition and nutritive value, types of cereals and millets
  - Gelatinization of starch and the factors affecting it, dextrinization, germination and fermentation
  - Toxic constituents in pulses.

UNIT III: Fruits and Vegetables **(12 Hours)**

- *Unit Description:* The unit is about composition, nutritive value and processing aspects fruits and vegetables. It also describes about various browning reactions that take place during food processing.
- *Subtopics:*
  - Classification of fruits and vegetables, composition and nutritive value; effect of processing on pigments.
  - Browning Reactions- enzymatic & non-enzymatic, role in food preparation and prevention of undesirable browning.

UNIT IV: Meat, Fish and Poultry **(8 Hours)**

- *Unit Description:* The unit will focus on composition, nutritive value and processing aspects of meat, fish and poultry.
- *Subtopics:*
  - Composition and nutritive value
  - Types of meat, fish and poultry and their selection/purchasing criteria Rigor mortis, Tenderization and Curing.

PRACTICAL:

No. of Students per Practical Class Group: 10-15

1. Weights and Measures. (2 Hours)
2. Detection of adulterants in food (2 Hours)
3. Gelatinization of starch and the factors affecting it. (2 Hours)

4. Preparation of dish using gelatinization of starch (2 Hours)
5. Dextrinization of starch and its application (2 Hours)
6. Germination of pulses and cereals (2 Hours)
7. Preparation of products using sprouts (2 Hours)
8. Fermentation of cereals and pulses (2 Hours)
9. Preparation of cereal-pulse fermented products (2 Hours)
10. Effect of heat, acid and alkali on water soluble plant pigments. (2 Hours)
11. Effect of heat, acid and alkali on fat soluble plant pigments. (2 Hours)
12. Maillard browning during food preparation. (2 Hours)
13. Enzymatic browning and its prevention. (3 Hours)
14. Caramelization reaction in food. (2 Hours)

ESSENTIAL/ RECOMMENDED READINGS (Theory and Practical):

1. Sethi, P. &Lakra, P. (2015). Aahar Vigyan, Poshan Evam Suraksha. Delhi: Elite Publishing House Pvt.Ltd.
2. Srilakshmi, B. (2012). Food Science. Delhi: New Age International Pvt. Ltd.
3. Suri, S. & Malhotra, A. (2014). Food Science Nutrition and Safety. Delhi: Pearson India Ltd.
   i. Online Question Bank and student E Resources: https://wps.pearsoned.co.in/suri_fsns_1/
   ii. Online Instructor Resources: www.pearsoned.co.in/sukhneetsuri
4. Potter,N., & Hotchkiss,J.H.(2007). FoodScience.5thEdition.Delhi:CBSPublishers.

5. Rekhi,, T. & Yadav, H. (2014). *Fundamentals of Food and Nutrition.* Delhi: Elite Publishing House Pvt. Ltd.

SUGGESTED READINGS:

1. Avantina S (2019). Textbook of Food Science and Technology, 3rd Edition, CBS Publishers and Distributors Pvt Limited
2. McWilliams, M. (2016). Foods: Experimental Perspectives. USA: Pearson.
3. Reddy,S.M. (2015).Basic Food Science and Technology. Delhi: New Age International Publishers.
4. Vaclavik, V.A. & Elizabeth, C. (2014). Essentials of Food Science. 4th Edition. New York: Springer.
5. Roday, S. (2018). *Food Science and Nutrition.* 3rd Edition. Delhi: Oxford University Press.
6. Geoffrey Campbell–Platt. Food Science and Technology. 1st edition (2009). Wiley–Blackwell
7. Sharma A. Textbook of Food Science and Technology 3rd Ed., (2022). CBS Publiher 9789386478009

Common Pool of Generic Elective (GE) Courses
Offered by Department of Home Sciences
Category-IV

GE HS 001
CARE AND WELLBEING ACROSS THE LIFESPAN

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
CARE AND WELLBEING ACROSS THE LIFESPAN	4	3	0	1	12th Pass	NIL

Learning Objectives

1. To understand the concept of care and well-being across the lifespan and talk in context to the current social world.
2. To demonstrate skills to promote well-being of self and others in the society.
3. To gain familiarity of programmes and policy initiatives present on care and wellbeing in India

Course Outcomes:

1. The student will be able to develop an understanding of the concept and dimensions of care and wellbeing of individuals in the contemporary social world.
2. The student will acquire knowledge of the many influences on care and wellbeing across human lifespan.
3. The student will build capacity to promote wellbeing of self and society at large.
4. The student will be familiar with program and policy initiatives present on care and wellbeing in India.

THEORY
(Credits 3; Periods 45)

Unit I: Care and Human Development Unit Description: The unit offers information about the concept of care across lifespan.	**12 Hours**
Subtopics: ● Definition, concepts & relevance of care ● Vulnerable periods in life that require care ● Principles & components of care ● Psychological, social, emotional and spiritual	

Unit II: Well-being and Human Development Unit Description: The unit provides information regarding the concept of wellbeing across lifespan, life crises and factors and experiences that promote wellbeing in human development.	**9 Hours**

Subtopics: ● Concept of well-being: physical, psychological, spiritual ● Life crises and well-being ● Factors & experiences that promote well-being	
Unit III: Care and wellbeing: Birth to adolescent years Unit Description: The unit focuses on the care and wellbeing from the period before birth up to the adolescent years.	**12 Hours**
Subtopics: ● Antenatal care: maternal, fetal and neonatal care ● Care of the young child ● Adolescent reproductive health and wellbeing ● Community and school health programs ● Nutrition and health for all ages	
Unit IV: Care and wellbeing Adulthood and Aging Unit Description: The unit addresses the care and wellbeing issues of the caregiver, role of the family, health, medical and insurance schemes and provisions for the care of the elderly.	**12 Hours**
Subtopics: ● Adulthood and old age: changing and adapting ● Stress, coping strategies and well-being of caregivers ● Counselling, yoga and meditation techniques ● Institutions, schemes and facilities for older adults	

Essential Readings

1. Daaleman, Timothy& Helton, Margaret (2018). Chronic Illness Care: Principles and Practice: Springer. (Chapters 9- 12 & Chapters 21-27) NICHD Early Child Care Research Network. (2005).
2. Child Care and Child Development: Results From the NICHD Study of Early Child Care. New York: Guildford Press. (Chapters 2-6)
3. Berk, L. (2013). Child development. 9th ed. Boston: Pearson.
4. Ronda C. Talley, Rhonda J. V. Montgomery, Caregiving: A Developmental, Life-Long Perspective, Pages 3-10
5. Ronda C. Talley, Lydia LaGue (2013) Caregiving Across the Lifespan: Research . Practice . Policy, Springer.
6. Santrock, J. W. (2011). Life-span development. New York: McGraw-Hill.

7. Singh, A. (Ed.) 2015. Foundations of Human Development. New Delhi: Tata McGraw- Hill.
8. Markin, L. (2013). Health and Well-Being across Life Course. Sage Publication, Inc. Chapter 2-7
9. Asumadu-Sarkodie, Samuel. (2012). Nutritional Problems and Intervention Strategies in India. (All Chapters)
10. Chao, R.C. (2015). Counselling Psychology: An Integrated Positive Psychological Approach. (Chapter 1-4)
11. Institute of Public Health in Ireland and the Centre for Effective Services (2016) Improving Health and Wellbeing Outcomes in the Early Years: Research and Practice Dublin: Institute of Public Health in Ireland and the Centre for Effective Services. (All Chapters).
12. Kamerman,S.B., Pipps, S., Ben-Arieh, A. (2010). From Child Welfare to Child Well-Being. Springer Publication. (Chapter 2, 5, 7, 12, 23)

Suggested Readings

1. Singhi, P. (1999). Child health & well-being: Psychological care within & beyond hospital walls. In T.S. Saraswathi (Ed.). Culture, socialization and human development. New Delhi: Sage.
2. Childhood in south Asia: A critical look at issues, policies and programmes. Conn.USA: Information Age.

PRACTICAL
(Credit 1; Periods 30)

● Use of various tools to understand care needs at different stages- childhood, adolescence, adulthood: Interview, Observation, Movies and Documentaries ● Lectures/ Talks/workshops on- Self-care and well-being, Counselling and Yoga/meditation ● Profile an organization to a senior citizen home/childcare institution to study care and well-being ● Psychometric tests- Well-being scale, Self-concept tests, Subjective well-being scale (WHO), any 2 personality tests	**30 Hours**

GE HS 005 : FUNDAMENTALS OF HUMAN NUTRITION

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite o f the course
		Lecture	Tutorial	Practical/		

				Practice		
FUNDAMENTALS O F HUMAN NUTRITION	**4**	**3**	**0**	**1**	**12th Pass**	**NIL**

Learning Objectives

1. To understand the relationship between food, nutrition and health.
2. To classify foods into various food groups and explain the concept of a balanced diet.
3. To describe the importance of various nutrients as well as list their food sources.
4. To be able to plan and prepare nutritious meals for an adult.

Course Outcomes

1. Relate how food affects health.
2. Classify foods into various food groups and explain the concept of a balanced diet.
3. Understand the importance of various nutrients and how these can be obtained from the diet.
4. Describe the considerations for planning and preparing balanced and nutritious meals for adults.

THEORY
(Credits 3; Periods 45)

Units	**No. of Hours**
Unit I: Basic Concepts in Nutrition Unit Description: Understanding basic terminology used in nutritional sciences and the importance of nutrition	**10 Hours**
Subtopics: ● Basic terms used in nutrition ● Understanding relationship between food, nutrition and health ● Functions of food-Physiological, psychological and social ● Basic food groups and concept of balanced diet	
Unit II: Nutrients Unit Description: Functions, dietary sources, requirements, effects of deficiency and/ or excess consumption of the various nutrients.	**20 Hours**
Subtopics: ● Energy- Concept of energy balance ● Carbohydrates and dietary fibre ● Lipids ● Proteins ● Fat soluble vitamins ● Water soluble vitamins ● Minerals	

Unit III: Healthy Eating Unit Description: Nutritional concerns and dietary guidelines for healthy eating for adults.	15 Hours
Subtopics: ● Factors influencing food choices ● Planning balanced meals and diets ● Nutritional concerns for adults ● Dietary guidelines for prevention of diet related lifestyle disorders ● Importance of physical activity and other lifestyle factors	

Essential Readings

1. Chadha R and Mathur P eds. (2015). Nutrition: A Lifecycle Approach. Hyderabad: Orient BlackSwan.
2. Khanna K, Gupta S, Seth R, Passi SJ, Mahna R, Puri S (2013). Textbook of Nutrition and Dietetics. Delhi: Phoenix Publishing House Pvt. Ltd.
3. Longvah T, Ananthan R, Bhaskarachary K and Venkaiah K (2017). Indian Food
4. Composition Tables. National Institute of Nutrition, Indian Council of Medical Research, Department of Health Research, Ministry of Health and Family Welfare, Government of India, Hyderabad.
5. NIN (2011). Dietary Guidelines for Indians- A Manual. Second edition. National Institute of Nutrition, Indian Council of Medical Research, Hyderabad.
6. Seth V, Singh K, Mathur P (2018). Diet Planning Through the Lifecycle Part I: Normal Nutrition- A Practical Manual. 6th Edition. Delhi: Elite Publishing House.

Suggested Readings

1. Byrd-Bredbenner C, Moe G, Beshgetoor D, Berning J (2013). Wardlaw‟s Perspectives in Nutrition, International Edition, 9th edition. New York: McGraw- Hill.
2. ICMR (2020). Nutrient Requirements for Indians-Recommended Dietary Allowances and Estimated Average Requirements. Published by National Institute of Nutrition, Hyderabad.
3. Sethi P, Lakra P. Aahar Vigyan, Poshan evam Suraksha (Hindi); First Ed; 2015; Delhi: Elite Publishing House (P) Ltd.
4. Siddhu, A, Bhatia, N, Singh, K, Gupta, S (2017). Compilation of Food Exchange List, Technical Series 6, Lady Irwin College, University of Delhi. Delhi: Global Books Organisation.
5. Suri S and Malhotra A (2014). Food Science, Nutrition and Safety. Dorling Kindersley (India) Pvt. Ltd, India

PRACTICAL

(Credit 1; Periods 30)

Practical	No. of Lectures
1. Making the right food choices **a.** Nutrient rich sources from different food groups **b.** Concept of high fat, salt, sugar (HFSS) foods **c.** Reading food labels	**10**
2. Planning a nutritious meal for adults a. Concept of food exchanges b. Calculating nutritional quality of diets c. Balancing meals according to nutrient requirements d. Healthy snacking options	**20**

GE HS 005 : TRAINING AND CAPACITY BUILDING

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
TRAINING AND CAPACITY BUILDING	**4**	**3**	**0**	**1**	**12th Pass**	**NIL**

Learning Objectives

1. To study the concept and significance of training and capacity building.
2. To understand the training process and the functions of different phases of training.
3. To know how different training approaches can be used to achieve various development goals.
4. To develop skills in designing, implementing and evaluating training programmes.

Course Outcomes

1. The student will be able to know the importance and scope of training for development.
2. The student will be able to learn the functions of different phases of the training process.
3. The student will be able to understand and critically evaluate the different training approaches and methodologies.

4. The student will be able to develop skills in planning, executing and evaluating training programmes for different stakeholders.

THEORY
(Credits 3; Periods 45)

Unit I: Training: Concept and Role in Development Unit Description: This Unit explores the concept, significance and different agencies involved in training for development. The unit focuses on adult learning and various approaches to train them. The Unit discusses the importance of evaluation and follow-up of training programmes. Various NGOs, GOs and Corporate initiatives in community development will also be discussed.	**9 Hours**
Subtopics: ● Nature, scope, advantages and limitations of training ● Goals, approaches and types of training ● Characteristics and principles of adult learning ● Government policies for training and capacity building of different stakeholders ● Agencies involved in training and development - NGOs, GOs and Corporate	
Unit II: **Roles and Responsibilities and Self-development of a Trainer** Unit Description: This Unit elaborates on the roles and responsibilities of a trainer. The various types of skills required of a trainer will be discussed. Concepts of self, self-development and personality development of a trainer will also be covered.	**12 Hours**
Subtopics: ● Roles and responsibilities of a trainer before, during and after a training programme ● Soft skills required by a trainer - communication, group mobilization leadership, team building, decision-making, networking and problem solving ● Technology-based skills - ICTs for facilitating the various aspects of the training process ● Concept of self and self-development of a trainer ● Need for personality development	
Unit III: **Methods and Techniques of Training** Unit Description: This Unit provides an insight into the different types of training methods and techniques which can be used in offline and online training programmes, including training in blended mode.	**12 Hours**

Subtopics: ● Tools and techniques for training (Brainstorming, Buzz Groups, Panel Discussion, Role Play, Focus Group Discussions, Films, Games and Stories) ● New techniques and innovations in training methods especially using technology	
Unit IV: **Designing, Executing and Evaluating Training Modules** Unit Description: This Unit focuses on analyzing training modules developed by different organizations - Government, National and International NGOs. The process of developing, mobilizing resources and implementing training programmes will be discussed. It also focuses on different ways of evaluating training programs for different stakeholders involved in the field of development.	**12 Hours**
Subtopics: ● Analysis of training programmes for different stakeholders ● Tools and techniques for training needs assessment ● Understanding various learning goals and outcomes for specific target groups ● Development of Training modules and materials ● Implementation of training programmes ● Methods of evaluation and follow-up of training	

Essential Readings

1. Agochiya D. (2002). Every Trainer's Handbook. New Delhi, Sage publisher.
2. Dhama, O.P. and Bhatnagar, O.P. (2003). Education and Communication for Development. New Delhi.
3. Gardner, A. & Brindis, C. (2017). Advocacy and Policy Change Evaluation: Theory and Practice. USA: Stanford Business Books. ISBN-13: 978-0804792561.
4. PRIA. (1998). A Manual for Participatory Training Methodology in Development. New Delhi: Society for Participatory Research in Asia.
5. PRIA (2002). Methods of Participatory Training. New Delhi. Participatory Research in Asia.

Suggested Readings

1. Bhatia S.K,2005, Training & Development; Concepts and Principles, Ch-1(3-8), ch-2(9-26), ch-3(28-38).
2. James W. Thacker C, (2004). Effectiveness Training-Systems, Strategies and Practices. Pearson Education.
3. Lyton R and PareekU. (1990). Training for Development. New Delhi, Vistaar Publications.
4. Subedi, N R, (2008). Advocacy Strategies and Approaches: A Training of Trainers Manual. International.

5. UNICEF. (2010). Advocacy toolkit. A guide to influencing decisions that improve children's lives.

PRACTICAL
(Credit 1; Periods 30)

	No. of Hours
● Exercises to understand roles and responsibilities of a trainer ● Undertake activities in building skills of a trainer. ● Undertake analysis of a variety of training modules. ● Development and conduct of training modules for specific client groups. ● Design, production and use of Training methods and materials. ● Evaluation of training programmes ● Visit to organizations involved in training and capacity building	**30**

GE HS 013 : SUSTAINABLE FASHION

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite o f the course
		Lecture	Tutorial	Practical/ Practice		
Sustainable Fashion	4	3	0	1	12th Pass	NIL

Learning Objectives

1. Spreading awareness about issues and challenges of sustainable fashion
2. Make students conscious consumers of textiles and apparel
3. Inculcating habits of reducing textile waste generation

Course Outcomes

1. The student will be able to gain knowledge of issues and challenges related to over consumption and non-sustainable fashion.
2. The student will be able to learning to choose garment consciously and become informed consumer
3. The student will be able to using green laundry practices to help environment
4. The student will be able to increasing life cycle of garments for less waste generation

THEORY
(Credits 3; Periods 45)

Unit I: Fashion & Sustainability Learning aspects of sustainability in relation to fashion and textiles.	**9 Hours**
Subtopics: ● Basics of sustainability ● The Fashion Business & sustainability issues ● Ethical & sustainable fashion in the changing global scenario ● Circular fashion ● Start-ups and big brands dealing with sustainability ● Measuring sustainability – How brands do it	
Unit II: Green Consumption Factors that should be kept in mind while selecting and purchasing apparel	**12 Hours**
Subtopics: ● Volumes of textile waste: Over consumption challenges ● Fashion based on values ● Locally made, globally relevant ● Local and connected: Designing with local artisans ● Reducing the speed in fashion consumption: Slow fashion, Durability, Appropriateness, Multifunctional garments, Trans-seasonal garments, emotionally durable design ● Standards, labels and organisations dealing with sustainable textiles and apparel	
Unit III: Ethical care and Maintenance Green practices for laundry and care of apparel.	**12 Hours**
Subtopics: ● Laundering frequency: Reducing consumers' need to clean ● Laundry detergents and softeners: Effectiveness and environmental concerns ● Machine vs line drying: Energy costs vs consumer needs ● Special care laundry: Environmental impacts and changing consumer demands	
● More efficient laundering practices ● Designing sustainable clothing that enables: low-impact care, extended use	
Unit IV: Intelligent Disposal Ways to increase the life of garments to reduce waste generation.	**12 Hours**

Subtopics: ● Slowing the flow of materials ● Take-back schemes ● Waste management strategies: Reuse of goods, repair and reconditioning of goods, recycling of goods, zero waste pattern ● Collaborative consumption: Sharing, pass me down, give away ● Vintage Clothing: The world of second-hand clothing ● Traditional Practices in Indian culture leading to sustainable consumption	

Essential Readings

1. Fletcher, K., & Grose, L. (2012). Fashion & sustainability: Design for change. Hachette UK
2. Fletcher, K. (2013). Sustainable fashion and textiles: design journeys. Routledge.
3. Gwilt, A., & Rissanen, T. (2012). Shaping sustainable fashion: Changing the way we make and use clothes. Routledge.
4. Jacques, P. (2020). Sustainability: the basics. Routledge.
5. Gardetti, M.A., & Torres, A.L. (Eds.). (2013). Sustainability in Fashion and Textiles: Values, Design, Production and Consumption (1st ed.). Routledge.
6. Pratibhan, M. Ed. (2017); Sustainability in Fashion & Apparels (Challenges & Solutions); Woodhead Publishing

Suggested Readings

1. Almeida, L. (2015). Ecolabels and organic certification for textile products. A Roadmap to sustainable textiles and clothing (pp. 175-196). Springer, Singapore.
2. Muthu, S. S. (Ed.). (2014). Roadmap to sustainable textiles and clothing: Eco-friendly raw materials, technologies, and processing methods. Springer.
3. Minney, S. (2011). Naked fashion: The new sustainable fashion revolution. New International
4. Mahapatra N. N. (2015); Textiles & Environment: Woodhead Publishing

PRACTICAL
(Credit 1; Periods 30)

Analysing Market and Consumer Practices: ● Market survey to evaluate presence of Sustainable garments in Indian retail market: Identify any one Multiband apparel outlet and analyse brands selling sustainable clothes, green standards marked on labels and any other information available on labels that talks about sustainability in production of that garment. ● Analysing personal wardrobe to assess individual buying practices ● Analysing personal laundry practices and evaluating its impact on the environment. ● Analysing personal garment disposal practices and finding ways to reduce the waste generation.	**20 Hours**
Case Study: ● Case study of an Indian Apparel Brand that is promoting Sustainable fashion. ● Case study on any one model of Collaborative consumption.	**10 Hours**

Suggested Readings

1. Kaur, J., & Singh, G. (2021). Cool Branding for Indian Sustainable Fashion Brands. Social and Sustainability Marketing: A Casebook for Reaching Your Socially Responsible Consumers through Marketing Science, 115.
2. Gwilt, A. (2020). A practical guide to sustainable fashion. Bloomsbury Publishing.

GE HS 020 :VISUAL MERCHANDISING

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite o f the course
		Lecture	Tutorial	Practical/ Practice		
Visual Merchandising	**4**	**3**	**0**	**1**	**12th Pass**	**NIL**

Learning Objectives

1. To introduce the concept and significance of visual merchandising in store design.
2. To impart knowledge regarding different types of visual displays and ways of achieving them.
3. To develop skill in creating aesthetically pleasing visual displays.

Course Outcomes

1. The student will be able to apprehend the key terms and principles involved in the components of visual merchandising.

2. The student will be able to understand the importance of visual merchandising and attractive visual display in communicating with customers.

3. The student will be able to create aesthetic visual displays on different themes in store design.

THEORY
(Credits 3; Periods 45)

Unit I: Introduction to Visual Merchandising Unit Description: The focus of this unit would be on understanding the concept, significance and key elements of visual merchandising.	**7 Hours**
Subtopics: ● Concept and Significance of Visual Merchandising ● Key elements of Visual Merchandising - Store Exterior, Store Layout, Store Interior, Interior display ● Factors Influencing Visual Merchandising ● Role of Visual Merchandiser	
UNIT II: Store Design Unit Description: This unit attempts to acquaint the students with various store designs, its components and the importance of colour and lighting therein.	**13 Hours**
Subtopics: ● Objectives and Characteristics ● Types of store design ● Interior components ● Exterior components ● Colour ● Lighting design	
Unit III: Design Display Unit Description: This unit will orient the students in understanding the various components of design displays.	**15 Hours**
Subtopics: ● Concept, Purpose, style and importance of displays ● Types of window displays ● Factors in window display ● Signage and Graphics ● Understanding of display fixtures ● Budgeting	

Unit IV: Materials and Technologies Unit Description: This unit will acquaint the students with the materials and technologies used in visual display and the global trends.	**10 Hours**
● Selection of materials ● Use of Latest Technologies: Augmented and Virtual reality tools, Robotics ● Global Trends	

Essential Readings

1. Morgan, T. (2014). Visual Merchandising: Window and in-store displays for retail, Laurence King Publishing, London
2. Bergstrom, B. (2009). Essentials of Visual Communication, Laurence King Publishing, London
3. Poore. J. (1994). Interior Colour by Design, Rockport Publishers.
4. Wiley, J. , (2010), Interior lighting for designers, John Wiley & Sons
5. Williams, R. (2007), Visual Communication: Integrating Media, Art, and Science, Routledge Communication Series

Suggested Readings

1. Khaus, K. (2006). Semantic turn a new foundation for design, CRC press
2. Landa, Robin. (2010), Advertising by design: Generating and Designing Creative Ideas Across Media, Second Edition, James Wiley
3. Linton, H. (1999). Color in Architecture: Design Methods for Buildings, Interiors and Urban Spaces, McGraw-Hill

PRACTICAL
(Credit 1; Periods 30)

Unit I: Design Exploration	**12 Hours**
Activities: ● Preparing a portfolio on elements and principles of visual design ● Creating Theme based mood boards	
● Market survey of materials used in display: accessories, props, signage, backdrop, banners, etc. ● Visit to retail stores for critical assessment of display arrangements.	

Unit II: Store Design and Displays	18 Hours
Activities: ● MKS system and techniques of measurement ● Identification and assessment of different layout plans ● Making a layout plan	
● Prop designing: Identification of types of props, material selection, creating a focal point through prop ● Planning and designing a prop ● Window Display Designing: Identification of types of window displays ● Assessment of selected window display ● Planning and designing a theme based window display ● Costing	

Essential Readings

1. Morgan, T. (2014). Visual Merchandising: Window and in-store displays for retail, Laurence King Publishing, London
2. Bergstrom, B. (2009). Essentials of Visual Communication, Laurence King Publishing, London
3. Poore. J. (1994). Interior Colour by Design, Rockport Publishers.
4. Wiley, J. , (2010), Interior lighting for designers, John Wiley & Sons
5. Williams, R. (2007), Visual Communication: Integrating Media, Art, and Science, Routledge Communication Series

GENERIC ELECTIVE (GE) – FT-01: FOOD PROCESSING AND PRESERVATION

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite o f the course
		Lecture	Tutorial	Practical/ Practice		
FOOD PROCESSING AND PRESERVATION	**4**	**3**	**0**	**1**	**12th Pass**	**NIL**

LEARNING OBJECTIVES:

1. To impart basic concept of Food colloids, Freezing, Dehydration processes and equipment useddduring the processing
2. To understand the Principles of thermal processing, Minimal Processing and hurdle technology
3. To understand the concepts of water disposal and sanitation.

COURSE OUTCOMES:

1. Understand the basic concepts of Food colloids, Freezing, Dehydration processes

andequipment used during the processing

2. Understand the Principles of thermal processing, Minimal Processing and hurdle technology
3. Understand the concepts of water disposal and sanitation.

UNIT I

Food Processing Operations **20 Hours**

Unit Description: Food Processing operations

Subtopics

- Refrigeration and Freezing

Requirements of refrigerated storage - controlled low temperature, air circulation and humidity, changes in food during refrigerated storage, progressive freezing, changes during freezing Freezing methods -direct and indirect, still air sharp freezer, blast freezer, fluidized freezer, plate freezer, spiral freezer and cryogenic freezing.

- Dehydration

Normal drying curve , effect of food properties on dehydration, changein food during drying, drying methods and equipments: air convection dryer, tray dryer, tunnel dryer ,continuous belt dryer , fluidized bed dryer, dryer, drum dryer, vacuum dryer , freeze drying, foam mat drying.

- Thermal Processing of Foods

Classification of thermal processes, Principles of thermal processing, commercial canning operations, Aseptic Processing, UHT Irradiation and microwave heating. Principles, Dosage, Applications of Irradiation, Mechanism of microwave heating and applications.

UNIT II: 10 Hours

Technology of Colloids in Food

Unit Description: **Technology of Colloids in Food**

Subtopics:

Surface chemistry (colloids, emulsions, foam, sols, gels, pectingels

Unit III: **Water Disposal and Sanitation** **10 Hours**

Unit Description: **Water Disposal and Sanitation**

Subtopics:

Waste water , hardness of water, break point chlorination, physical and chemical nature of impurities, BOD, COD, waste water treatment, milkplant sanitation, CIP system, sanitizers used in food industry

Unit IV: **Minimal processing and hurdle technology** **05 Hours**

Unit Description: **Minimal processing and hurdle technology**

PRACTICAL **DURATION: 30 HRS (CREDIT 1)**

- Study of canning equipment (Forming, Flanging, Seaming, Exhausting and Retort)
- Canning of foods

- Preservation of food by the process of freezing
- Drying of food using Tray dryer/other dryers
- Study of thawing characteristics of frozen foods
- Preparation of brix solution and checking by hand refractometer
- Analysis of water
- Minimal Processing of food
- Application of colloidal chemistry in food preparation

ESSENTIAL READINGS:

1. Deman, J.M. (2007).Principles of Food Chemistry, 3rd Ed. Springer.
2. Potter, N. and Hotchkiss H. (2007).Food Science. New Delhi: CBS Publication.
3. Ramaswamy, H. and Marcotte, M. (2009).Food Processing Principles and Applications.CRC Press.

SUGGESTED READINGS:

1. Fellows' Food Processing Technology Principles and Practice 5th Edition (2022)Elsevier Publishing

TEACHING LEARNING PROCESS

- Lectured based teaching
- Power point presentations
- Experimental learning through practicals
- Along with pedagogy of flipped classroom students are encouraged to participate actively in theclassroom through regular presentations on curriculum based topics, peer assessment

ASSESSMENT METHODS

- As per University of Delhi norms
- Assessment methods - quiz, identification tests, assignments
- End semester exams for theory and practical
- Feedback given to students for improving
- Continuous evaluation of practicals

KEYWORDS

Food Preservation, Food Processing, Colloidal chemistry, BOD, COD, Sanitation, Effluent system.

BSc. (Life Science)

B.Sc. (Life Science) with Botany as one of the core discipline

Category-III

(Semester-I)
Based on
Undergraduate Curriculum Framework 2022 (UGCF)
(Effective from Academic Year 2022-23)

University of Delhi

Course Title	Nature of the Course	Total Credits	Components			Eligibility Criteria/ Prerequisite
			Lecture	Tutorial	Practical	
Plant Diversity & Systematics	DSC-Botany	04	02	-	02	Chemistry+Physics+Biology/ Biological studies/Biotechnology

Semester I

DISCIPLINE SPECIFIC CORE COURSES (DSC)
SEMESTER-I

Course Code BOT-DSC-1
Course Title: Plant Diversity and Systematics
Total Credits: 04 (Credits: Theory 02, Practical 02)
Total Hours: Lectures- 30, Practical- 15 classes of 4 hours each

Objective:

To make students aware about the diversity of plants and microbes present on the planet and their evolutionary relationships.

Learning Outcomes:

This course will be able to impart basic knowledge and understanding of:

- the diversity of plants and microbes
- the possible relationships between each group
- their general characteristics
- approaches used for identification and classification of various groups of plants

Unit 1: Diversity of Life **Lectures: 01**

Classifying the diversity of life: Domains of Life –Eubacteria, Archaea and Eukaryotes

Unit 2: Microbes **Lectures: 04**

Viruses: General account; Replication, Lytic and Lysogenic cycle; Bacteria: structure, wall-less forms (L-forms, Mycoplasma), asexual reproduction and genetic recombination

Unit 3: Algae **Lectures: 03**

Brief introduction of major classes: Blue-green, Green, Brown and Red algae. Diagnostic features of identification; morphology, reproduction and classification with special reference to *Nostoc*, *Volvox* and *Spirogyra*.

Unit 4: Fungi **Lectures: 03**

Diagnostic features of identification; morphology, reproduction and classification with special reference to *Rhizopus, Penicillium and Agaricus*; Lichens (a general account).

Unit 5: Bryophytes, Pteridophytes and Gymnosperms **Lectures: 06**

Characteristic features of identification; morphology and reproduction of Bryophytes, Pteridophytes and Gymnosperms with special reference to *Marchantia, Funaria*, *Pteris* and *Pinus* (only morphology).

Unit 6: Angiosperms **Lectures: 02**

Diagnostic features, Structure of flower, types of inflorescence

Unit 7: Systematics **Lectures: 01**

Aims, fundamental components of systematics, description, identification, nomenclature, phylogeny, biosystematics.

Unit 8: Systematics in Practices **Lectures: 07**

Taxonomic Hierarchy- Concept of taxa and categories, Botanical Nomenclature- principles and rules; Type method; Author citation; Valid publication; Rejection of names, Principle of priority and its limitations, names of hybrids and cultivars.

Unit 9: Systems of classification **Lectures: 03**

Classification: Artificial, Natural and Phylogenetic. An outline of Bentham and Hooker's (up to series only) and Engler and Prantl's (up to Subclasses) systems of classification and their merits and Demerits. APG System.

Practicals: (60 hours)

1. **Viruses:** Electron Micrographs of TMV and Bacteriophage, Specimens of virus infected plants (any two).
2. **Bacteria:** Electron Micrographs of a bacterium, types through permanent slides/photographs, specimens of infected plants (any two).
3. **Algae:** Study of vegetative and reproductive structures of (a) *Nostoc* (b) *Volvox* (c) *Spirogyra* through temporary preparations and permanent slides.
4. **Fungi:** Study of vegetative and reproductive structures of (a) *Rhizopus,* (b) *Penicillium* and (c) *Agaricus* through temporary preparations and permanent slides/specimens/photographs.
5. **Lichens:** Crustose, Foliose and Fruticose (specimens/ digital resources)
6. **Bryophytes:** Study of (a) *Marchantia:* morphology of thallus, W.M. rhizoids and scales, V.S. thallus through gemma cup, W.M. gemmae (all temporary slides), V.S. antheridiophore, archegoniophore, L.S. sporophyte (all permanent slides), (b) *Funaria*: detailed study and classification from W.M. rhizoids, operculum, peristome, spores and permanent slides of archegonia, antheridia and capsule.
7. **Pteridophytes:** Study of *Pteris:* T. S. of Rachis, V.S. of Sporophyll and W.M. of sporangium.
8. **Gymnosperms:** Study of *Pinus* morphology of long & dwarf shoot, male and female cones (specimens) and T.S. of needle (permanent slides only).

9. **Herbarium technique:** Mounting of a properly dried and pressed specimen of any wild plant on the herbarium sheet with complete herbarium label.
10. Taxonomic study of characters of one plant from each of the following families (any four): Malvaceae, Solanaceae, Asteraceae, Fabaceace, Liliaceae.

Suggested Readings:

1. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, 4th edition. Singapore, John Wiley and Sons (Asia).
2. Kumar, H.D. (1999). Introductory Phycology, 2nd edition. Delhi, Delhi: Affiliated East-West. Press Pvt. Ltd.
3. Bhatnagar, S.P., Moitra, A. (1996). Gymnosperms. New Delhi, Delhi: New Age International (P) Ltd. Publishers.
4. Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Prayagraj: U.P.: Central Book Depot.
5. Pelczar, M.J. (2001). Microbiology, 5th edition. New Delhi, Delhi: Tata McGraw-Hill Co.
6. Tortora, G.J., Funke, B.R., Case. C.L. (2007). Microbiology. San Francisco, U.S.A: Pearson Benjamin Cummings.
7. Raven, P.H., Evert, RF., Eichhorn, S.E. (2013). Biology of Plants, 8th edition, New York, NY: W.H. Freeman and Company.
8. Sethi, I.K., Walia, S.K. (2018). Text book of Fungi and Their Allies. (2nd Edition), Medtech Publishers, Delhi.
9. Vashishta, P.C., Sinha, A.K., Kumar, A. (2010). Pteridophyta. New Delhi, Delhi: S. Chand & Co Ltd.
10. Singh, G. (2020). Plant Systematics: Theory and Practice, 4th edition. CBS Publishersand Distributers, New Delhi.
11. Simpson, M.G. (2020). Plant Systematics, 3rd edition, Elsevier Academic Press, San Diego, CA, U.S.A.
12. Gupta R. 2011. Plant Taxonomy: past, present, and future. New Delhi: The Energy and resources Institute (TERI).
13. Judd W.S., Campbell C.S., Kellogg, E. A., Stevens, P.F., Donoghue M.J. (2015). Plant Systematics: A Phylogenetic Approach 4th Edition Sinauer Associates, Oxford University Press. USA.
14. http://www.mobot.org/MOBOT/research/APweb/. (for APG IV classification).

Keywords: **Bacteria, Viruses, Bryophytes, Pteridophytes, Gymnosperms, Angiopserms, Classification**

B.Sc. (Life Science) with Chemistry as one of the core discipline Category-III

(Semester-I)
Based on
Undergraduate Curriculum Framework 2022 (UGCF)
(Effective from Academic Year 2022-23)

University of Delhi

Course Title	Nature of the Course	Total Credits	Components			Eligibility Criteria/ Prerequisite
			Lecture	Tutorial	Practical	
Basic Concepts of Organic Chemistry	DSC-Chemistry	04	02	-	02	Chemistry+Physics+Biology/ Biological studies/Biotechnology

Course Code : CHEM-DSC-01
Course Title: Basic Concepts of Organic Chemistry
Total Credits: 04 (Credits: Theory-02, Practical-02)
Total Lectures: Theory- 30, Practical- 15 classes of 4 hours each

Objectives: The course is infused with the recapitulation of fundamentals of organic chemistry and the introduction of the concept of visualizing the organic molecules in a three-dimensional space. To establish the applications of these concepts, a study of diverse reactions through mechanisms is included. The constitution of the course strongly aids in the paramount learning of the basic concepts and their applications.

Learning Outcomes:
By the end of the course, the students will be able to:

- Understand and explain the differential behavior of organic compounds based on fundamental concepts learnt.
- Understand the fundamental concepts of stereochemistry.
- Formulate the mechanism of organic reactions by recalling and correlating the fundamental properties of the reactants involved.
- Learn and identify many organic reactions and their mechanisms including electrophilic addition, nucleophilic addition, nucleophilic substitution, electrophilic substitution and rearrangement reactions.

Unit 1: Fundamentals of organic chemistry Lectures: 05

Types of Electronic displacements: Inductive effect, Resonance effect, Hyperconjugation, Electromeric Effect. Reactive intermediates and their stability: carbocations, free radicals, carbanions, benzyne, carbenes.
Acidity and basicity in organic compounds (comparison of carboxylic acids, alcohols, phenols, primary, secondary and tertiary aliphatic amines, aniline and its derivatives)

UNIT 2: Stereochemistry Lectures: 07

Types of projection formulae: Flying Wedge Formula, Newmann, Sawhorse and Fischer representations and their interconversion.
Stereoisomerism: Concept of chirality (upto two carbon atoms). Configurational isomerism: geometrical and optical isomerism; enantiomerism, diastereomerism and meso compounds). Threo and erythro; D and L; *Cis-trans* nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and *E*/*Z* nomenclature (for upto two C=C systems).
Conformational isomerism with respect to ethane, butane and cyclohexane.

UNIT 3: Types of Organic Reactions (Including reactions of alkenes, alkyl and aryl halides, alcohols, aldehydes, ketones)

Lectures: 18

Electrophilic addition reactions

Electrophilic addition reaction (with respect to propene, propyne, 3,3-dimethyl-1-butene): Hydration, Addition of HX in the absence and presence of peroxide, Hydroboration oxidation, Addition of bromine (with stereochemistry).

Nucleophilic addition reactions

Nucleophilic addition reaction of carbonyl compounds: Addition of HCN, ammonia derivatives (Hydroxylamine, Hydrazine, Semicarbazide and 2,4-DNP), the addition of carbanion (Aldol condensation, Claisen Schmidt, Benzoin condensation, Perkin reaction, reactions involving Grignard reagent).

Elimination and Nucleophilic substitution reactions

Nucleophilic substitution reaction (S_N1 and S_N2) in alkyl halides (mechanisms with stereochemical aspect), alcohols (with nucleophiles like ammonia, halides, thiols, ambident nucleophiles (cyanide and nitrite ion)), ethers (Williamson ether synthesis), Elimination reaction (E1 & E2), elimination *vs* substitution (*w.r.t.* potassium t-butoxide and KOH); Nucleophilic aromatic substitution in aryl halides-elimination addition reaction *w.r.t.* chlorobenzene, including the effect of nitro group (on the ring) on the reaction. relative reactivity and strength of C-X bond in alkyl, allyl, benzyl, vinyl and aryl halides towards substitution reactions

Electrophilic substitution reactions

Electrophilic Aromatic substitution with mechanism (benzene)- sulphonation, nitration, halogenation, Friedel craft acylation :*o*-, *m*- and *p*- directive influence giving examples of toluene/nitrobenzene/ phenol/ aniline/ chlorobenzene.

Reactive intermediates and Rearrangement Reactions

Free radicals (Birch Reduction); *Carbocations* (Pinacol-Pinacolone, Wagner-Meerwein, Rearrangement, and Beckmann rearrangement); *Carbanions (*Michael Addition); *Carbenes* (Reimer-Tiemann).

PRACTICALS: 60 hours

(Laboratory periods: 15 classes of 4 hours each)

1. Purification of an organic compound by crystallization (from water and alcohol) and distillation, Criteria of purity: Determination of M.P.
2. Determination of boiling point of liquid compounds. (Boiling point lower than and more than 100 °C by distillation and capillary method)
3. Detection of extra element
4. Preparations: (Mechanism of various reactions involved to be discussed).

a. Bromination of phenol/aniline.
b. 2,4-Dinitrophenylhydrazone of aldehydes and ketones
c. Semicarbazone of aldehydes/ ketones
d. Aldol condensation reaction using green method.
e. Bromination of Stilbene.
f. Acetanilide to p-Bromoacetanilide.

The above derivatives should be prepared using 0.5-1g of the organic compound. The solid samples must be collected and may be used for recrystallization and melting point.

References:

Theory:

1. Sykes, P.(2003), **A Guide Book to Mechanism in Organic Chemistry,** 6th Edition Pearson Education.
2. Eliel, E. L. (2001), **Stereochemistry of Carbon Compounds**, Tata McGraw Hill.
3. Morrison, R. N.; Boyd, R. N., Bhattacharjee, S.K. (2010), **Organic Chemistry**, 7th Edition, Pearson Education.
4. Bahl, A; Bahl, B. S. (2019), **Advanced Organic Chemistry**, 22nd Edition, S. Chand.

Practical:

1. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. (2012), **Vogel's Textbook of Practical Organic Chemistry**, Pearson.
2. Mann, F.G.; Saunders, B.C. (2009), **Practical Organic Chemistry**, Pearson Education.
3. Dhingra, S; Ahluwalia V.K., (2017), **Advanced Experimental Organic Chemistry**, Manakin Press.
4. Pasricha, S., Chaudhary, A. (2021), **Practical Organic Chemistry: Volume I**, I K International Publishing House Pvt. Ltd., New Delhi.

Teaching Learning Process:

- Blend of conventional blackboard teaching, modern teaching learning tools and
- Computational infrastructure- based instructions and Practical training.
- Problem solving and quizzes for enhanced understanding of the concepts.
- Explaining the handling and usage of the hardware and softwares required for solution to the given set of problems.

Assessment Methods:

- Presentations by individual student/ group of students
- Class Tests at periodic intervals.
- Written assignment(s)
- End semester University theory examination presentations by individual student/ group of students

Keywords: Chirality, Electrophilic addition, Nucleophilic addition, Nucleophilic substitution, Electrophilic substitution

B.Sc. (Life Science) with Zoology as one of the core discipline

Category-III

(Semester-I)
Based on
Undergraduate Curriculum Framework 2022 (UGCF)
(Effective from Academic Year 2022-23)

University of Delhi

Course Title	Nature of the Course	Total Credits	Components			Eligibility Criteria/ Prerequisite
			Lecture	Tutorial	Practical	
Diversity of Animals	DSC-Zoology	04	02	-	02	Chemistry+Physics+Biology/ Biological studies/Biotechnology

Course Code : ZOO-DSC-01
Course Title: Diversity of Animals
Total Credits: 04 (Credits: Theory-02, Practical-02)
Total Lectures: Theory- 30 hrs., Practical- 15 classes of 4 hours each

Objectives: The objective of this course is to teach the students concepts of morpho- taxonomy aswell as understand the characteristics and physiological aspects of unicellular and metazoan animals. The course lays emphasis on creating awareness and concern towards significance of animal diversity for human survival and its socio- economic importance. In addition to this, the course is aimed at nurturing skills of conducting scientific inquiry and experimentation in the field of animal diversity to acquire knowledge of fundamental concepts and theories of animal diversity.

Learning Outcomes:

By the end of the course, the students will be able to:

- Acquire knowledge of diversity of non-chordate and chordates.
- Learn characteristics, morphotaxonomy, structural organization and physiological life systemof diverse animal groups.
- Understand the economic importance of non-chordates and chordates and their importance inthe ecosystem.
- Learn evolutionary relationships and phylogeny of invertebrates and vertebrates to structuralas well as functional similarities.

Unit I– Introduction ***02 hrs.***

Introduction to five kingdom classification system, General characters of kingdom Animalia and basis of its classification (with special reference to coelom), Concept of Taxonomic Hierarchy (up to species level), significance of binomial nomenclature.

Unit II: Protista to Pseudocoelomates **09 hrs.**

Characteristics of acoelomates and pseudocoelomates. Locomotory organelles and locomotion inProtozoa, Canal system in Porifera, Polymorphism in Cnidaria (Hydrozoa), Life cycle of *Taeniasolium* and its Parasitic adaptations, Life cycle of *Ascaris lumbricoides* and its Parasitic adaptations.

Unit III: Coelomates ***09 hrs.***

General features of coelomates, Metamerism in Annelida, Vision in Arthropoda, Metamorphosis in Insects. Torsion and detorsion in Gastropoda. Pearl Formation, Water-vascular system in Asteroidea

Unit IV: Chordates **10 hrs.**

Salient features of protochordates and chordates, Retrogressive metamorphosis in protochordates, Osmoregulation, Migration, and Parental care in fishes, Parental care in Amphibians, Flight adaptations and Migration in birds, Biting mechanism in snakes, Origin of mammals.

PRACTICAL **[60 hours]**

1. General Characteristics and Classification up toclasses: Protista, Porifera, Cnidaria,Platyhelminthes, Nemathelminthes. Study of museum specimens: *Amoeba,Euglena, Paramecium, Sycon, Euplectella, Obelia, Physalia, Aurelia, Metridium,* larval stage of *Taenia solium,* Male and female *Ascaris lumbricoides.*

2. General Characteristics and Classification up to classes: Annelida, Arthropoda, Mollusca, Echinodermata. Study of museum specimens: *Aphrodite, Nereis, Chaetopterus, Pheretima, Hirudinaria, Palaemon, Cancer, Limulus, Palamnaeus, Scolopendra, Chiton, Dentalium, Pila, Unio, Octopus, Pentaceros, Echinus, Cucumaria, Antedon.*

3. Study of following specimens, general characteristics and classification: *Balanoglossus, Amphioxus, Herdmania.*

4. Study of following specimens, general characteristics and classification up to order: *Petromyzon, Pristis, Exocoetus, Hippocampus, Hyla, Salamander Ichthyophis/Uraeotyphlus, Naja, Viper, Hydrophis, Chameleon, Uromastix, Milvus, Anas, Psittacula, Loris, Pteropus, Sorex*

5. Submission of report on an excursion to a Sanctuary/ Biodiversity Park.

Note: Classification to be followed from Ruppert, E.E., Fox, R.S., Barnes R.D. "*Invertebrate Zoology*" 7th Edition., Cengage Leaning, India" & Young, J. Z. (2004) *The Life of Vertebrates*. III Edition. Oxford university press.

Recommended Books:

1. Ruppert, E.E., Fox, R.S., Barnes, R. D. *Invertebrate Zoology: A Functional EvolutionaryApproach*. 7th Edition, Cengage Learning, India.
2. Young, J. Z. (2004) *The Life of Vertebrates*. III Edition. Oxford university press.
3. Barrington, E.J.W. (2012) *Invertebrate Structure and Functions*. II Edition, EWP Publishers.
Pechenik, J. A. (2015) *Biology of the Invertebrates*. VII Edition, McGraw-Hill Education
4. Campbell & Reece (2005). Biology, Pearson Education, (Singapore) Pvt. Ltd.
5. Kardong, K. V. (2002). Vertebrates Comparative Anatomy. Function and Evolution. TataMcGraw Hill Publishing Company. New Delhi.
6. Pough H. *Vertebrate Life*, VIII Edition, Pearson International.

7. Lal, S.S. (2012), Practical Zoology Invertebrate.
8. Lal S.S. (2015-16), Practical Zoology Vertebrate.
9. P. S. Verma (2010), A Manual of Practical Zoology: Chordates.

Teaching Learning Process:

- Blend of conventional blackboard teaching, modern teaching learning tools and computational infrastructure- based instructions and Practical training.
- Problem solving and quizzes for enhanced understanding of the concepts.
- Explaining the handling and usage of the hardware and software required for solution to thegiven set of problems.

Assessment Methods:

- Presentations by Individual Student/ Group of Students
- Class Tests at Periodic Intervals.
- Written assignment(s)
- End semester University Theory Examination Presentations by Individual Student/ Group of Students

REGISTRAR

UNIVERSITY OF DELHI

CNC-II/093/1(23)/2022-23/
Dated: 13.03.2023

NOTIFICATION

Sub: Amendment to Ordinance V

[E.C Resolution No. 38-1/ (38-1-3) dated 08.12.2022]

Following addition be made to Appendix-II-A to the Ordinance V (2-A) of the Ordinances of the University;

Add the following:

Syllabi of Semester-II of the following departments under Faculty of Science based on Under Graduate Curriculum Framework -2022 to be implemented from the Academic Year 2022-23.

FACULTY OF SCIENCE

DEPARTMENT OF BOTANY

Category-I

B.Sc. (H) Botany

DISCIPLINE SPECIFIC CORE COURSE – 4: Microbiology and Plant-Microbe Interactions

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Microbiology and Plant-Microbe Interactions	**04**	**2**	0	**2**	10+2 from any recognized Board with Biology	**Nil**

Learning Objectives

The Learning Objectives of this course are as follows:

To impart basic understanding about microbial world and their interactions with plants.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understanding microbes and their roles and applications.
- Understanding about modes of reproduction of Viruses, Archaebacteria, Eubacteria.
- Understand plant-microbe interaction

SYLLABUS OF DSC-4

Unit 1: Introduction 02 Hours

Microbial world, Growth and nutrition of microbes with reference to nutritional media.

Unit 2: Viruses 07 Hours

Discovery; Physicochemical and biological characteristics; Classification (Baltimore); General structure with special reference to viroids and prions, DNA and RNA viruses; General account and mechanism of replication, lytic and lysogenic cycle; General account of viral diseases of plants (mosaic and vein clearing disease).

Unit 3: Bacteria 09 Hours

Discovery, General characteristics; Types - Archaebacteria, Eubacteria, Wall less forms (Mycoplasma, Phytoplasma and Spheroplasts); Cell structure; Nutritional types; Reproduction - vegetative, asexual and recombination (conjugation, transformation and transduction); General account of bacterial diseases of plants (Citrus canker, Angular leaf spots of cotton).

Unit 4: Applied Microbiology 04 Hours

Economic importance of viruses with reference to vaccine production, role in research, medicine and diagnostics and agriculture. Economic importance of bacteria with reference to their role in agriculture and industry (fermentation and medicine).

Unit 5: Plant-Microbe interactions 08 Hours

General account of Plant-microbe interactions; Plant growth promoting rhizobacteria (PGPR); Mechanism of nitrogen fixation by Cyanobacteria and Rhizobia; Types of mycorrhizal association with plants; Ectomycorrhiza and Endomycorrhiza and their effects on plant growth.

Practicals:

1. Study of Viruses: Electron micrographs / Model - T-Bacteriophage and TMV; specimens/digital resources/ Line drawings of Lytic and Lysogenic Cycle. 08 Hours
2. Study of Bacteria: Electron micrographs of bacteria; Types of Bacteria from temporary/permanent slides. Endospore, Binary fission, Conjugation, Root nodule through specimens/digital resources. 08 Hours
3. Study of Plant Growth Promoting Rhizobacteria (PGPR) through specimens/digital resources (at least three). 04 Hours
4. Gram staining to differentiate between Gram-positive and Gram-negative bacteria. 08 Hours
5. Study of *Rhizobium* from root nodules of a leguminous plant. 08 Hours
6. Isolation of *Anabaena* from *Azolla* leaves. 08 Hours
7. Histochemical staining to observe Arbuscular Mycorrhizal Fungi (AMF) colonization in roots. 08 Hours
8. Study of Bacterial diseases (Citrus canker, Angular leaf spots of cotton) and viral diseases

of plants (mosaic and vein clearing disease) through specimens/digital resources.

08 Hours

Suggested Readings:

1. Pelczar, M.J. (2001) Microbiology, 5th edition. New Delhi, Delhi: Tata Mc-Graw- Hill Co.
2. Tortora, G.J., Funke, B.R., Case, C.L. (2016) Microbiology: An Introduction, Indian edition, Pearson India Education Services Pvt. Limited, Noida, India
3. Prescott, L.M., Harley J.P., Klein D. A. (2005). Microbiology, 6th edition: McGraw Hill, New Delhi.
4. Gupta, R., Chugh, G. (2022) Plants, Microbes and Diseases 1st Edition, I.K. International Pvt. Ltd., Delhi.
5. Subba Rao, N.S. (2000) Soil Microbiology, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi

Additional Resources:

1. Talaro, K.P., Talaro, A. (2006). Foundations in Microbiology. Mc-Graw Hill, New Delhi

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 5: Plant Resources and Economic Botany

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Plant Resources and Economic Botany	**04**	**2**	0	**2**	10+2 from any recognized Board with Biology	**Nil**

Learning Objectives

The Learning Objectives of this course are as follows:

- To familiarize students with the economic importance of diverse plant species and train them in identifying plants of economic importance through field visit/s, live plant specimens, herbarium specimens and digital resources.
- To make students understand the importance of various plant parts and derived products used as food, fibers, medicines, oils and other economically important products.
- To acquaint students with the processing of various economically important plant resources and train them to identify and analyses nutrients using simple microchemical tests.

Learning outcomes

The Learning Outcomes of this course are as follows:

- This course would provide students with information about the economic importance and products derived from plants and their roles in our daily lives.
- Students will learn to perform micro-chemical tests to study presence of various components.
- Students will explore the regional diversity in food crops and other plants and their ethnobotanical importance.

SYLLABUS OF DSC-5

Unit 1: Introduction and Origin of Cultivated Plants **02 Hours**
Importance of Plant Resources; Vavilov's concept for the Origin of cultivated plants; Centres of Origin (Primary and Secondary); Centres of diversity, Harlan's concept of gene pools. Plant Genetic Resources and their conservation.

Unit 2: Cereals **04 Hours**
Wheats (Origin, Evolution of Wheats (tetra- & hexaploid), Morphology, Production, and Economic Importance of Hexaploid Wheat); Rice (Origin-Monophyletic and Polyphyletic, Production, Morphology, Comparison between *indica* and *japonica* Rice, Parboiling,

Economic Importance); Other cereals: Maize, Barley, Oats, Millets (jowar, bajra, ragi) and Pseudocereals.

Unit 3: Legumes **03 Hours**

General account (Nutritive Value of Pulses, Protein Malnutrition, Lathyrism, Favism, Ecological Importance); chick pea and pigeon pea (Production, Morphology and Economic Importance). Other Legumes: Lentil, Cluster Bean, Lathyrus, Beans, Pea, Cowpea, Fodder legumes and Green manure crops.

Unit 4: Sugars and Starches **03 Hours**

Sugarcane (Morphology, Ratooning, Nobilization, Products and By- products); Potato (Morphology, Tuber Anatomy, Seed Tubers vs True Potato Seeds and Economic uses).

Unit 5: Spices, Condiments & Flavourings **03 Hours**

General Account (Spices, Condiments, Culinary Herbs and Essences, with examples), Importance of Spices, Clove (Morphology, Anatomy of part used and Economic Importance) and Black Pepper (Morphology, Anatomy of part used and Economic Importance). Other examples: Ginger, Turmeric, Cinnamon, Saffron, Cardamom, Chillies & Pepper, Fennel, Coriander, Cumin, Vanilla, Nutmeg.

Unit 6: Beverages **02 Hours**

Types of Beverages (Alcoholic and Non-Alcoholic) with examples, Tea and coffee (Morphology, Chemistry, Processing and Economic Importance)

Unit 7: Fibres and Fibre-yielding plants **03 Hours**

Classification of Fibres based upon their Origin (surface fibres, bast fibres, and leaf fibres, with examples); Jute (morphology, extraction and economic importance), Cotton (*Gossypium* species, morphology, processing and economic importance) Comparison between Jute and Cotton fibers. Other examples: Flax, Hemp and Coconut.

Unit 8: Oil-Yielding Plants **03 Hours**

Fatty Oils and Essential Oils, Comparison between Fatty Oils and Essential Oils; Fatty Oils (Classification with examples, keeping quality), Groundnut (Morphology and Economic Importance); Essential Oils (General characteristics, Methods of Extraction and Economic Importance, with examples). Other examples: Rapeseed & Mustard (canola), Coconut, Olive, Castor, Cottonseed, Sesame, Soybean, Linseed.

Unit 9: Medicinal and Drug-Yielding Plants **02 Hours**

Brief Account of Therapeutic Drugs with Examples; Morphology, Chemical Constituents, Economic Importance of *Cinchona, Rauwolfia, Digitalis.*

Unit 10: Fumigatory & Masticatory **02 Hours**

Tobacco (Morphology, species - *Nicotiana tabacum* & *N. rustica*), Processing, Products, Economic Importance and Health Hazards), *Cannabis*, *Papaver* (Morphology, Chemical Constituents, Economic Importance)

Unit 11: Rubber **01 Hour**

Para Rubber - *Hevea brasiliensis* (Morphology, Tapping of latex, Processing, Products and Economic Importance)

Unit 12: Fruits & Nuts **01 Hour**
Tropical & Temperate; *Citrus*, Mango, Banana, Apple, Pineapple, Papaya; Nuts: Cashew, Walnut, Almond & Pistachio.

Unit 13: Vegetables **01 Hour**
Common examples of root crops, leafy vegetables (herbag), fruit seed vegetables;

Practicals:
1. **Cereals**: Wheat (Habit Sketch, L.S/T.S. grain, W.M. starch grains, Micro-chemical tests), Rice (Habit Sketch, study of paddy and grain, W.M. starch grains, Micro- chemical tests). Millets - Pearl Millet, Finger Millet and Pseudocereals - Amaranth Grain, Quinoa (specimens/digital resources and grains) **08 Hours**
2. **Legumes**: Chickpea, pigeonpea (Habit, fruit, seed structure, Micro-chemical tests). **04 Hours**
3. **Sugars and Starches**: Sugarcane (Habit Sketch, Products and By-products, Cane Juice-Micro - chemical tests); Potato (Habit Sketch, Tuber morphology, T.S. tuber to show localization of starch grains, W.M. starch grains, Micro-chemical tests). **08 Hours**
4. **Spices**: Clove, Blackpepper (Habit and sections L.S./T.S.), Saffron, fennel (specimen/digital resources) **04 Hours**
5. **Beverages**: Tea (plant specimen, tea leaves), Coffee (plant specimen, beans) **04 Hours**
6. **Fibres**: Jute (specimens/digital resources of *Corchorus capsularis* and *C. olitorious*, T.S. stem, test for cellulose and lignin on section of stem and fibre). Cotton (specimen, W.M. seed to show lint and fuzz; W.M. fibre and test for cellulose) **08 Hours**
7. **Oil-Yielding Plants**: Fatty Oils: Groundnut (Habit-specimen, Fruit, seeds, Microchemical Tests) Coconut-Habit (photograph), Fruit, T.S. nut, Mustard - (Habit- specimen, Fruit, seeds); Essential Oils: Habit Sketch of Rose, Jasmine, Vetiver, Sandalwood and *Eucalyptus* (specimens/photographs) **08 Hours**
8. **Drug-Yielding plants:** Habit - Fever Bark Tree, Poppy, Foxglove and Cannabis (Specimens/ Photographs) **08 Hours**
9. **Tobacco:** *Nicotiana tabacum* and *N. rustica* (specimens/photographs), Tobacco Products
10. **Rubber:** Para Rubber-Habit, Tapping of latex (Specimen/photograph), Rubber Products **04 Hours**
11. **Petro-crops:** *Saccharum officinarum* , *Jatropha* sp. **04 Hours**

Suggested Readings:

1. Kochhar,S.L. (2012). Economic Botany in Tropics. New Delhi, India: MacMillan & Co.
2. Kochhar, S.L. (2016). Economic Botany – A Comprehensive Study, 5th Edition. New Delhi, India: Cambridge University Press.
3. Wickens, G.E. (2001). Economic Botany: Principles & Practices. The Netherlands: Kluwer Academic Publishers.
4. Chrispeels, M.J., Sadava, D.E. (1994). Plants. Genes and Agriculture. Jones & Bartlett-Publishers.
5. Berg L, (2008). Introductory Botany: Plants, People, And The Environment, Thomson Brooks/Cole.
6. Cook F.E.M. (1995). Economic Botany: Data Collection Standard Royal Botanic Garden, Kew, Richmond.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 6: Plant Systematics

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Plant Systematics	**04**	**2**	**0**	**2**	10+2 from any recognized Board with Biology	**Nil**

Learning Objectives

The course will help students gain knowledge about:

- The basics of plant systematics and its inter-relationships with allied subject areas

Learning outcomes

On completion of the course the students will be able to:

- understand technical terminology used in plant taxonomy
- apply the terminologies to describe, identify and classify flowering plants
- search and analyse taxonomic information from internet-based scientific databases and other resources
- interpret and evaluate the concept of species and evolutionary processes in angiosperms
- comprehend and compare various systems of classifications
- recognise diversity in local/regional flora
- appreciate the significance and application of systematics in science and welfare of society

SYLLABUS OF DSC-6

Unit 1: Introduction **02 Hours**

Identification, Classification (types) and Nomenclature, Phylogeny; Major contributions - Parasara, Charaka, Theophrastus, Bauhin, Tournefort, Linnaeus, Adanson, de Candolle, Bessey, Hutchinson, Takhtajan, Bremer, MW Chase

Unit 2: Resources in Plant Identification **02 Hours**

Literature (Floras, Manuals, *Icones*, Monographs, Revisions, Journals, e-resources); Herbaria and Botanical gardens (in brief)

Unit 3: Systematics - An Interdisciplinary Science **04 Hours**

Relevance of palynology, cytology, phytochemistry and molecular data (cite at least (streak, spread & pour), replica plating, serial dilution.

three examples from each with emphasis on application in resolving taxonomic problems - details of techniques to be excluded)

Unit 4: Botanical Nomenclature **05 Hours**
Principles and rules (ICN); Ranks and names; Principle of priority and its limitations; Concept of 'Type', Author citation, Valid publication, Rejection of names; Nomenclature of hybrids

Unit 5: Systems of Classification **06 Hours**
Taxonomic hierarchy; Concept of species (morphological, biological and evolutionary); Classifications - Bentham and Hooker's (up to series), Engler and Prantl's (upto sub-class) and Angiosperm Phylogeny Group (APG) classification (major clades).

Unit 6: Approaches in Systematics **06 Hours**
Terms and concepts (primitive and advanced, homology and analogy, parallelism and convergence, monophyly, paraphyly, polyphyly, clades and grades).
Phenetics - Principles, Methodology, Characters; Selection of OTUs, Character weighing and Coding; Cluster analysis; Phenogram.
Cladistics - Principles, Methodology, Characters; Selection of EUs, Character weighing and Coding; Cluster analysis; Cladogram

Unit 7: Evolution of Angiosperms **05 Hours**
Concept of a primitive flower (Euanthial theory and Pseudanthial theory); Basal Living Angiosperms; Herbaceous origin; Co-evolution of angiosperms with animals.

Practicals:
1. Field trip/ Visit to any herbaria/ Botanical Garden. **04 Hours**
2. To prepare at least five herbarium specimens and identify them using available resources (Literature, herbaria, e-resources, taxonomic keys) and classify up to family level (according to Bentham and Hooker's classification and comapare it with APG IV System in the field note book). **08 Hours**
3. Description of taxa using semi-technical terms and identification of the families according to Bentham and Hooker's classification and compare the placement of family with APG IV System (Only placement of family according to APG IV system to be mentioned) **48 Hours**

Note: Any **twelve** families from the following list to be studied with **at least two** specimens (**or one** where limitations exist).

List of Suggested Families (*mandatory)
Acanthaceae, Amaranthaceae, *Apiaceae, Apocynaceae, *Asteraceae, *Brassicaceae, *Euphorbiaceae, *Fabaceae, *Lamiaceae, Liliaceae, *Malvaceae, Moraceae, *Poaceae, *Ranunculaceae, *Solanaceae

Suggested Readings:

1. Simpson, M. G. (2019). Plant systematics. 3rd Edition, Academic press.
2. Singh, G. (2019). Plant Systematics- An Integrated Approach. 4th edition. CRC Press, Taylor and Francis Group.
3. Stuessy, T.F. (2009). Plant Taxonomy: The Systematic Evaluation of Comparative Data, 2nd edition, Columbia University Press.
4. Taylor, D.V., Hickey, L.J. (1997) Flowering Plants: Origin, Evolution and Phylogeny.

CBS Publishers & Distributers, New Delhi.
5. Pandey, A. K., Kasana, S. (2021). *Plant Systematics*. 2nd Edition. CRC Press Taylor and Francis Group
6. http://www.mobot.org/MOBOT/research/APweb/
7. Maheshwari, J. K. (1963). The flora of Delhi. Council of Scientific & Industrial Research.
8. Maheshwari, J. K. (1966). Illustrations to the Flora of Delhi. Council of Scientific & Industrial Research.
9. Harris, J. G., Harris, M. W. (2001). Plant Identification Terminology: An Illustrated Glossary. Spring Lake, Utah: Spring Lake Pub. Spring Lake, Utah.
10. Radford, A. E. (1974). Vascular plant systematics. Harper & Row Publishers, New York, London.
11. Judd, W.S., Campbell, L.S., Kellogg, E.A., Stevens, P.F., Donoghue, M.J. (2016) Plant Systematics: A Phylogenetic Approach. 4th edition. Sunderland, MA: Sinauer Associates

Additional Resources:

1. The Angiosperm Phylogeny Group, Chase, M. W., Christenhusz, M. J.M., Fay, M. F., Byng, J. W., Judd, W. S., Soltis, D.E. Mabberley, D. J., Sennikov, A. N., Soltis, P. S., Stevens, P. F. (2016). An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV. Botanical journal of the Linnean Society 181 (1): 1–20.
2. Soltis, D. E., Bell, C. D., Kim, S., Soltis, P. S. (2008). Origin and early evolution of angiosperms. Annals of the New York Academy of Sciences 1133: 3-25.
3. Scutt, C. P. (2021). The origin of angiosperms. In Evolutionary developmental biology: a reference guide. Cham: Springer International Publishing.
4. https://www.mobot.org/MOBOT/research/APweb/treeapweb2s.gif
5. https://www.digitalatlasofancientlife.org
6. http://apps.kew.org/herbcat/navigator.do
7. https://efloraofindia.com/
8. https://powo.science.kew.org/
9. Page, R.D.M., Holmes, E.C. (1998). Molecular Evolution: A phylogenetic approach. Blackwell Publishing Ltd.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

Category II

B.Sc. Life Science with Botany as one of the Core Discipline

DISCIPLINE SPECIFIC CORE COURSE – 2: Genetics and Molecular Biology

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Genetics and Molecular Biology	04	2	0	2	10+2 from any recognized Board with Biology	Nil

Learning Objective

To apprise students with the basic principles of Genetics and Molecular Biology and its applications in living systems

Learning Outcome:

Students would be able to

- understand the fundamentals of Mendelian inheritance and non-Mendelian inheritance.
- describe the concepts of linkage and crossing over and their usage in constructing genetic maps.
- gain knowledge about chromosomal aberrations and mutations.
- become familiar with structure and function of nucleic acids with reference to replication, transcription and translation.
- understand the mechanisms of gene regulation

SYLLABUS OF DSC-02

Unit 1: Mendelian genetics and extrachromosomal inheritance **06 Hours**

Mendel's principles of inheritance; chromosomal theory of inheritance; incomplete dominance and co-dominance; multiple allelism; lethal alleles (dominant and recessive lethals); deviations of Mendelian dihybrid ratio (Epistatic interactions-Dominant, Recessive, Duplicate Dominant, Duplicate Recessive, Duplicate Gene Interaction, Dominant - Recessive); polygenic inheritance; numericals based on above; extrachromosomal inheritance (Chloroplast Inheritance: Variegation in Four O` clock plant; Mitochondrial inheritance: petite mutants in yeast); Maternal effect (shell coiling in snails).

Unit 2: Structure & Function of the gene **02 Hours**

Classical and molecular concept of gene - Benzer's cis-trans complementation analyses & fine map of rII locus in phage. Central Dogma.

Unit 3: Linkage, crossing over and chromosome mapping **03 Hours**

Discovery; linkage and crossing over; recombination frequency: two factor crosses; sex linkage (eye color in *Drosophila*; colour blindness and haemophilia in humans).

Unit 4: Variation in chromosome number and structure **03 Hours**

Haploidy, polyploidy, autopolyploidy (examples: banana, watermelon), allopolyploidy (ancestry of wheat) and aneuploidy (Down's, Turner's and Klinefelter's syndromes); Deletion; Duplication (Bar eye in *Drosophila*); Inversion (paracentric and pericentric); Translocation (*Rhoeo, Oenothera;* Robertsonian translocation, Familial Down Syndrome and cancer).

Unit 5: DNA structure and replication **03 Hours**
Discovery of DNA; Watson and Crick model of DNA structure; semiconservative replication (Meselson & Stahl's experiment); DNA replication mechanism in *E. coli* (semi-discontinuous mode and Y-fork).

Unit 6: Mutations **03 Hours**
History; mutation types with examples [spontaneous and induced; somatic and germinal; biochemical mutations; point mutations (base substitutions): transition and transversion; deletion and frameshift mutations), missense and nonsense mutations]; Molecular basis of mutation; Mutagens - physical (UV and X-rays), chemical mutagens [Base analogues, deaminating, alkylating and intercalating agents] and Transposons.

Unit 7: Gene expression **06 Hours**
Genetic code; Structure and types of RNA; Transcription and Translation in Prokaryotes; Transcription, RNA processing and Translation in Eukaryotes.

Unit 8: Regulation of gene expression: Prokaryotes **04 Hours**
Inducible and repressible systems, negative and positive control of lactose operon and tryptophan operon. **Eukaryotes -** Transcriptional gene silencing - Role of chromatin, DNA methylation, histone modifications; cis-acting elements (promoters & enhancers/silencers), trans-acting factors; Post-transcriptional gene regulation (RNA interference/ PTGS), role of small RNAs, Epigenetics.

Practicals:
1. To study mitosis in *Allium cepa* through squash preparation of root tips. **04 Hours**
2. To study meiosis in *Allium cepa* through smear preparation of anthers. **08 Hours**
3. To study incomplete dominance and deviations of Mendelian dihybrid ratio (12:3:1, 9:3:4, 9:7, 15:1, 13:3) through seed samples. **08 Hours**

a) Human Genetics b) Study of autosomal & sex-linked dominant & recessive inheritance through pedigree analyses. c) n ABO blood group testing using kits, d) To study the syndromes (Down's, Klinefelter's, and Turner's) through karyotypes **08 Hours**

4. To study chromosomal aberrations: reciprocal translocation through squash preparations of *Rhoeo* anthers. Complex translocation ring, quadrivalents, lagging chromosomes, dicentric/inversion bridge through permanent slides. **08 Hours**
5. To prepare LB medium, inoculate and maintain (spread plate, streak plate, pour plate & serial dilution methods) *E. coli* cultures. **08 Hours**
6. To isolate genomic DNA from cauliflower and *E.coli*. Visualise using agarose gel electrophoresis. **08 Hours**
7. To estimate DNA by diphenylamine method. **04 Hours**

Suggested Readings:
1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (1991). Principles of Genetics, 8th edition. New Delhi, Delhi: John Wiley & sons.
2. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2020). Introduction to Genetic Analysis, 12th edition. New York, NY: W.H. Freeman and Co.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2020). Concepts of Genetics, 12th edition. San Francisco, California: Benjamin Cummings.

Additional Resources:

1. Russell, P. J. (2010). Genetics- A Molecular Approach. 3rd Edition. Benjamin Cummings
2. Snustad, D.P., Simmons, M.J. (2016). Principles of Genetics, 7th Edition. New Delhi, Delhi: John Wiley & sons
3. Pierce, B. A. (2020). Genetics: A Conceptual Approach Seventh Edition, Macmillan

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

COMMON POOL OF GENERIC ELECTIVES (GE) COURSES OFFERED BY THE DEPARTMENT of BOTANY

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Ethnobotany	04	2	0	2	12^{th} Pass	NIL

Learning Objectives

- To have the knowledge of the plants used by the local communities, tribals, ethenic groups, their nutritive and medicinal value.

Learning outcomes

After studying this course the student will gain knowledge about:

- Students would have an understanding of the treasure, value and usefulness of the natural products and their efficient use by the local communities as food and medicine and their conservation practices.

SYLLABUS OF GE-6

Unit 1: Introduction to Ethnobotany and Basic Taxonomy **06 Hours**

Introduction, concept, scope and objectives; Ethnobotany as an interdisciplinary science, databases and knowledge resource (Traditional Knowledge Digital Library), The relevance of ethnobotany in the present context; Major and minor ethnic groups or Tribals of India, and their life styles, Plants used by the indigenous societies: a) Food plants b) Medicinal plants c) intoxicants and beverages d) Resins and oils and miscellaneous uses.

Unit 2: Applied Ethnobotany **07 Weeks**

Role of ethnobotany in modern Medicine, Medico-ethnobotanical sources in India; Significance of the following plants in ethnobotanical practices (along with their habitat and morphology): a) *Azadiractha indica,* b) Ocimum sanctum, c) *Vitex negundo,* d) *Gloriosa superba,* e) *Tribulus terrestris,* f) *Pongamia pinnata,* g) *Cassia auriculata,* h) *Indigofera tinctoria*.

Unit 3: The Ecology of Ethnobotany **07 Hours**

Ethnobotany—Spirits, Lore, Material Cultures, Folk Magic, Narcotics, Stimulants; Nutritional Ethnobotany – Agriculture, foraging and wild foods; Linguistic

Ethnobotany—Botanical Classification and Ethics; Medicinal Ethnobotany and Ethnopharmacology; Ethnoveterinary knowledge

Unit 4: Research Methods in Ethnobotany **06 Hours**

Etic and Emic Perspectives: a) Field work; b) Herbarium; c) Ancient Literature and oral traditions; d) Archaeological finding inferences; e) Religious and sacred places.

Unit 5: Protecting Knowledge **04 Hours**

Ethnobotany and legal aspects, Ethnobotany as a tool to protect interests of ethnic groups, Sharing of wealth concept with few examples from India, Biopiracy, Intellectual Property Rights and Traditional Knowledge; Case studies of traditional medicines leading to development of modern pharmaceutical products (use of *Trichopus zeylanicus* by kanhi tribe and Artemesia sp. for malaria cure)

Practicals: **60 Hours**

- Collection, identification and preparation of herbarium of three ethno-botanically important plants with appropriate references
- Preparation of crude extract of ethno-botanically important plants with appropriate references (any method to be used)
- Project work-documentation, literature survey, and collection of information on ethno-botanically useful plants from traditional healers)

Suggested Readings:

- Jain, S.K. (2010). Manual of Ethnobotany. Rajasthan: Scientific Publishers.
- Martin, G.J. (1995). Ethnobotany: A Methods Manual. Chapman Hall
- Cunningham, A.B. (2001). Applied Ethnobotany: People, Wild Plant Use and Conservation. Earthscan, London.
- Young, K.J. (2007). Ethnobotany. Infobase Publishing, New York.
- Schmidt, B.M., Cheng, D.M.K. (Eds.) (2017). Ethnobotany: A Phytochemical Perspective. John Wiley & Sons Ltd. Chichester, UK.
- Research papers from various Scientific Journals for case studies.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

14

GENERIC ELECTIVES (GE-7)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Viewing and Capturing Diversity in Nature	**4**	**2**	0	2	12th Pass	**Nil**

Learning Objectives

The Learning Objectives of this course are as follows:

- To provide students a comprehensive introduction to photography, including both aesthetic and technique.
- To get students to rethink the environment in which they live through the medium of pictures.
- To become thoroughly familiar with digital camera and smartphone photography technology.
- To develop a working knowledge of digital image modification,
- To understand the importance and use Nature photography in your business and career prospects.
- To enhance appreciation for the tremendous beauty inherent in plants and gardens.

Learning outcomes

On successful completion of this course, a student will be able to:

- understand the digital camera or smartphone camera functions.
- use different photographic equipment to enhance their photographic skills.
- know about the photographic variables with weather and season.
- exploit their photographic work in various professions and for entrepreneurship development.

SYLLABUS OF GE-7

Unit 1: Basics of Photography and Videography **10 Hours**

History and development of digital photography, Introduction to lenses and camera, Definitions (Megapixel, Magnification, Resolving Power, Zoom feature, contrast and brightness of image), Types of lenses, analog camera, Digital camera, SLR camera, imaging system in camera. Role of lighting, depth of field, focal length, colour and contrast in photography, types of photography and techniques, working of camera: exposure, shutter speed and aperture.

Understanding Image: Types of shots: distance, angle and movement; digital image basics: image format, resolution, aspect ratio, Pixels, DPI and PPI, composition and aesthetics: rules and guidelines.

Unit 2: Diversity of Nature: Colours and Landscape 10 Hours

Importance of plants as natural products, General characteristic features of various plant life forms (Single celled, colonial forms, filamentous forms and multicellular and complex forms). General account of diverse landscaping patterns based on different geographical locations, plant adaptations and ecological interactions, role of plant pigments (diverse forms of alga, leaf coloration, floral pigments) in aesthetic appeal.

Unit 3: Diversity around us - A magnified view 05 Hours

Principles of Microscopy: Dissection and compound microscope, scanning electron microscope. importance of sample preparation for microscopy, staining techniques.

Unit 4: Photographic visualisation of Nature 05 Hours

Sensitization of Biodiversity conservation; Thematic depiction of nature in Art galleries; Eco-tourism: a general account; role of photography in Eco-tourism and ecological discourse.

Practicals: 60 Hours

1. To study the parts of a digital camera.
2. To study the principle and working of digital camera/ smartphone camera.
3. Working and handling of light microscopes (Dissection and Compound).
4. Study of plant forms through microscopic lens (Single celled, colonial forms, filamentous forms, multicellular and complex forms).
5. To study techniques of capturing shots (using light and lenses effectively, macro and micro photography, wide angle and close-ups).
6. Study of plant adaptations through photographs (Aquatic and desert plants).
7. To capture and understand the Ecological Interactions.
8. Identification of different plant life forms through online available tools/ search engines.
9. Outdoor/ Campus Photography: Plants, Environment, Landscapes and cityscape, Mushrooms.
10. Project Work: To make a portfolio of diverse landscaping patterns/ selected theme through outdoor visits.

Suggested Readings:

1. Ang., T. (2008). Fundamentals of modern Photography. London, Mitchell.
2. Patterson, F. (1999). The Art of Seeing. Key Porter Books.
3. Fitzharris, T. (2011). Landscape Photography. Firefly Books.
4. Kelby, S. (2012). The digital photography book. Peachpit Press.
5. Langford, M., Fox, A., Smith, R.S. (2013). Langford basic photography: the guide for serious photographers. Amsterdam: Focal Press/Elsevier.
6. Peterson, B. (2016). Understanding exposure: how to shoot great photographs with any camera. AmPhoto Books.
7. Karp, G. (2010). Cell Biology, 6th edition. New Jersey, U.S.A.: John Wiley & Sons.

Additional Resources:

1. Sharma, P.D. (2010.) Ecology and Environment. Meerut, UP. Rastogi Publications.

2. Wilson, K., Walker, J. (2018). Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVES (GE-8)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Agricultural Botany and Weed Science	**4**	**2**	**0**	2	12th Pass	**Nil**

Objectives: To gain the knowledge on

- Requirement of the conditions for seed germination
- Growth hormones, plant development and flowering conditions
- Weeds and the methods to control weeds

Learning Outcomes:

After completion of this course the students would be able to understand:

- how is the quality of seeds judged and how are the suitable conditions for the seed germination created?
- how are the growth, flowering and fruiting in plants managed through the applications of hormones?
- how are weeds managed in commercial crops?

Unit 1: Seed Physiology **04 Hours**

Seed dormancy types, factors, mechanism and methods for breaking dormancy, seed viability, seed vigour and seed germination.

Unit 2: Physiology of Crop Growth and Yield **05 Hours**

Growth, methods of growth analysis, factors affecting growth, concept of phytotronics and Fertilizers (Nitrogen, Phosphorus, biofertilizers).

Unit 3: Regulation of Growth and Development **04 Hours**

Role of hormones in plant growth and development, growth retardant.

Unit 4: Reproductive Physiology and Senescence **06 Hours**

Physiology of flowering, Photoperiodism, vernalization, physiology of fruit ripening, senescence and regulation of senescence.

Unit 5: Biology of Weeds **04 Hours**

Ecology of weeds, competition, reproduction of weeds. Allelopathy and Invasive Plants.

Unit 6: Crop Management Practices **07 Hours**

Mechanical, Cultural, Biological and Chemical Weed control. Some abnoxious weeds and their management, Integrated pest management (IPM).

Practicals: (60 hours)

1. To study the effect of ethylene on shelf life of cut flowers./ To study the effect of cytokinin on leaf senescence.
2. To test the viability of weed seeds.
3. To study the allelopathic effects of weeds on germination of crop seeds.
4. To study the effect of herbicides on seed germination and seedling growth of weeds.
5. Determination of pH and analysis of a soil sample for carbonates, chlorides, sulphates, organic matter and base deficiency by rapid field tests.
6. To perform the qualitative test for Nitrogen (NH^{4+}, NO^{3-}, urea) in a fertilizer and the soil sample.
7. Demonstration / photographs for the mechanisms used in herbicide application.
8. Field trip to a crop land to study weeds.
9. Submission of any two properly dried and mounted weed specimens with the herbarium label.

Suggested Readings:

1. Ashton, F. M., Monaco, T. J. (2002). Weed Science: Principles and Practices. New Jersey, U.S.: John Wiley and Sons. Inc.
2. Hopkins, W. G., Huner, N. P. A. (2009). Introduction to Plant Physiology, 4th edition. New Delhi, Delhi: Wiley India Pvt. Ltd.
3. Taiz, L., Zeiger, E., Moller, I. M., Murphy, A. (2018). Plant Physiology and Development International 6th edition. New York, NY: Oxford University Press, Sinauer Associates.
4. Mandal, R.C. (1990). Weeds, weedicides and weed control: Principle and Practice. New Delhi, Delhi: Agro Botanical Publishers.
5. Rao, V. S. (1999). Principles of Weed Science. Oxford and IBH Publishers, New Delhi.
6. Subramanian, S. (2017). All about weed control. New Delhi, Delhi: Kalayani publishers.

GENERIC ELECTIVES (GE-9)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Intelligent Systems in Plants	04	2	**0**	2	12th Pass	**Nil**

Learning Objectives

- The course aims to lay the foundations on plant intelligence and develops understanding of the intelligent adaptively variable behaviour of plants.

Learning outcomes

The Learning Outcomes of this course are as follows:

- The students will be learning the concepts of intelligence, distinction between development and intelligent behaviour and morphological /adaptive strategies employed by plants to survive.

SYLLABUS OF GE-09

Unit 1: Introduction **04 Hours**

An Introduction to Plant Structure (Morphological and Anatomical details), compartmentalization

Unit 2: Plants and Intelligence **03 Hours**

Introduction to Plant Intelligence and Memory - Historical Perspective

Unit 3: Sensory Biology **04 Hours**

Cell to cell communication, Self-recognition, Recognition of Neighbours and Relatives.

Unit 4: Learning in Plants **06 Hours**

Habituation learning, Learning by association (Rhizosphere and Mycorrhizae), Adaptive Intelligence (Hydrophytes, Xerophytes, Parasites, Carnivorous plants, Thermogenic plants), Response to water, heat, salt, cold stress. Mechanical and chemical defence against predators with special reference to secondary metabolites.

Unit 5: Intelligent Behaviour of Plants **13 Hours**

A Guided tour to Plant Movements (Tropic Movements, Movement towards gravity, light, tracking sun movements, prey driven movements, liberation movements), Intelligent response to minerals and light (Seed germination, root cap, response of shoot, leaf morphology and anatomy), Unique pollination and seed dispersal mechanisms, Osmosis, Short and long-distance transport of water and food, Metabolic redundancy, Life Cycle Signaling in response to external stimuli (Reactive Oxygen Species, peptides, receptors, hormones).

Practicals:(60 hours)

1. Study the structure of plant cell using temporary mount
2. Study of the cell as an osmotic system (Plasmolysis and Deplasmolysis).
3. Demonstration of the phenomenon of protoplasmic streaming in *Hydrilla* leaf.
4. Extraction and qualitative analysis of alkaloids, flavonoids, tannins and phenols.
5. To study the phenomenon of seed germination (effect of light).
6. To study light sensitivity and etiolation vs. de-etiolation.
7. Morphology and orientation of chloroplasts in leaves growing in light and dark, plasmodesmata connections and plasma membrane receptors. (through photographs or other digital resources)
8. Estimation of total photosynthetic pigments.
9. Study of (a) Root cap (b) Trichomes: non-glandular and glandular (c) Leaf Morphology and Anatomy. (d) pulvinus anatomy in *Mimosa pudica.* (e) Specialised motor tissue at the base of monocot leaves
10. (a) Study of morphological and anatomical adaptations of hydrophytes, xerophytes. (b). Study of biotic interactions of the following: Stem parasite (*Cuscuta*), Root parasite (*Orobanche*) Epiphytes, Predation (Insectivorous plants).
11. Pollination types (selected) and associated seed dispersal mechanisms

Suggested Readings:

1. Mauseth, J.D. (1988). Plant Anatomy. The Benjammin/Cummings Publisher, USA.
2. Evert, RF., Eichhorn, S.E. (2012). Raven Biology of Plants, 8th edition, New York, NY: W.H. Freeman and Company.
3. Koller, D. (2011). The Restless Plant. Edited by Elizabeth Van Volkenburgh, Haward University Press, Cambridge, Massachusetts, and London, England.
4. Crang, R., Lyons-Sobaski, S., Wise, R. (2018) Plant Anatomy- A Concept based approach to the structure of seed plants, Springer Nature, Switzerland.

Additional Resources:

Trewavas A. (2017). The foundations of plant intelligence. Interface Focus 7: 20160098. http://dx.doi.org/10.1098/rsfs.2016.0098

GENERIC ELECTIVES (GE-10)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Informatics and Statistics for Biology and Allied Sciences	**4**	2	0	2	**12th Pass**	**Nil**

Learning Objectives

The Learning Objectives of this course are as follows:

- To build an understanding in silico/computational approaches in various aspects of understanding biology and biological research.

- To build analytical skills and integrate the principles of statistical analyses for robust interpretation of biological observations.

Learning outcomes

The student will understand

- the basics of bioinformatics and develop awareness of the interdisciplinary nature of this field.
- learn about biological databases, sequence retrieval, alignment, and phylogenetic analysis using various tools.
- understand the basic concept of sampling methods, data classification, presentation and statistical analysis.

SYLLABUS OF GE-10

Unit 1: Introduction to Bioinformatics 03 Hours

Historical background, Aims and scope, bioinformatics in Genomics, Transcriptomics, Proteomics, Metabolomics, Systems biology and drug discovery, Applications and Limitations in bioinformatics.

Unit 2: Biological databases 04 Hours

Introduction to biological databases - Primary, secondary and composite databases. Study of following databases: NCBI (GenBank, PubChem, PubMed and its tools (BLAST)), introduction to EMBL, DDBJ, UniProt, PDB and KEGG.

Unit 3: Basic concepts of Sequence alignment 04 Hours

Similarity, identity and homology. Concepts of alignment (gaps and penalty); Alignment – pairwise and multiple sequence alignments

Unit 4: Molecular Phylogeny 04 Hours

Introduction to Molecular Phylogeny, methods of construction of phylogenetic trees: maximum parsimony (MP), maximum likelihood (ML) and distance (Neighbor-joining) methods.

Unit 5: Biostatistics 02 Hours

Biostatistics – definition, Basics of descriptive and inferential statistics; Limitations and applications of biostatistics.

Unit 6: Data types and presentation 03 Hours

Primary and secondary data; Sampling methods (in brief); tabulation and presentation of data;

Unit 7: Descriptive Statistics 04 Hours

Measures of central tendency - mean, median, and mode; Measures of dispersion - range, standard deviation, and standard error.

Unit 8: Correlation and Regression 03 Hours

Types and methods of correlation, Introduction to simple regression equation; similarities and dissimilarities between correlation and regression.

Unit 9: Statistical inference 03 Hours

Hypothesis – (simple hypothesis), student's t test, chi-square test.

(Note: Numerical based questions of unit 7, 8 and 9 should be covered only in practical)

Practicals: 60 Hours

1. Biological databases (NCBI, EMBL, UniProt, PDB)
2. Literature retrieval from PubMed
3. Sequence retrieval (protein and gene) from NCBI (formats - FASTA, GenBank and GenPept formats)
4. Protein Structure retrieval from PDB (in pdb format) and visualization by viewing tools (Ras Mol/ J mol/Mol*/Swiss 3D Viewer/Pymol)
5. Multiple sequence alignment (MEGA/Clustal omega)
6. Construction of phylogenetic tree (PHYLIP/ MEGA/ Clustal omega).
7. Making of Bar diagrams, Pie chart, Histogram, Frequency polygon, Cumulative frequency curve (any four) in the given data set using Microsoft Excel
8. Calculation of mean, mode, median, standard deviation and standard error (through manual calculation and using Microsoft Excel) (use only ungrouped data)
9. Calculation of correlation coefficient values by Karl Pearson's /Spearman Rank methods (through manual calculation and using Microsoft Excel)
10. Student's t-test (using Microsoft Excel only), chi square test (Manual and using Microsoft Excel)

Suggested readings:

1. Ghosh, Z., Mallick, B. (2008). *Bioinformatics – Principles and Applications*, 1st edition. New Delhi, Delhi: Oxford University Press.
2. Baxevanis, A.D., Ouellette, B.F., John (2005). *Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins*, 3rd edition. New Jersey, U.S.: Wiley & Sons, Inc.
3. Roy, D. (2009). *Bioinformatics*, 1st edition. New Delhi, Delhi: Narosa Publishing House.
4. Andreas, D., Baxevanis, B.F., Francis, Ouellette. (2004). *Bioinformatics: A practical guide to the analysis of genes and proteins*, 3rd edition. New Jersey, U.S.: John Wiley and Sons.
5. Khan, I.A., Khanum, A. (2004). Fundamentals of Biostatistics, 5th edition. Hyderabad: Ukaaz publications.
6. Campbell, R.C. (1998). Statistics for Biologists. Cambridge, U.S.A.: Cambridge University Press

Additional Resources:

1. Pevsner, J. (2009). Bioinformatics and Functional Genomics, 2nd edition. New Jersey, U.S.: Wiley Blackwell.
2. Xiong, J. (2006). Essential Bioinformatics, 1st edition. Cambridge, U.K.: Cambridge University Press.
3. Mount, D.W. (2004). Bioinformatics: Sequence and Genome analysis 2nd edition, Cold Spring Harbor Laboratory Press, USA.
4. Zar, J.H. (2012). Biostatistical Analysis, 4th edition. London, London: Pearson Publication.
5. Pandey, M. (2015). Biostatistics Basic and Advanced. New Delhi, Delhi: M V Learning.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DEPARTMENT OF ZOOLOGY

Category-I
BSc. (H) Zoology

DISCIPLINE SPECIFIC CORE COURSE– 4 (DSC-4): Non-Chordata: Coelomates

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Non-Chordata: Coelomates	04	02	0	02	Class XII pass with Biology/ Biotechnology	NIL

Learning Objectives

The learning objectives of this course are as follows:

- The course aims to impart in-depth knowledge about the diverse life forms from the taxonomic positions of Annelida to Echinodermata.
- It will help the students to identify the body plan types of complex non-chordates and their systematic organization based on evolutionary relationships, structural and functional affinities.
- The course will help the students to understand the characteristic morphological, adaptive and anatomical features of diverse animals
- The course will help students to understand the economic and ecological significance of various animals in human life.
- The course will create interest among them to explore and appreciate the animal diversity in nature.

Learning Outcomes

By studying this course, students will be able to

- learn about the importance of systematics, taxonomy, and structural organization ofnon-chordate coelomates.
- recognize the diversity of non-chordates living in varied ecological habitats.
- critically analyse the organization, complexity and characteristic features of non-chordates.
- comprehend the economic importance of non-chordates, their interaction with the environment and their role in the ecosystem.
- enhance collaborative learning and communication skills through practical sessions, teamwork, group discussions, assignments, and projects.

SYLLABUS OF DSC-4

UNIT – I Annelida **07 Hours**

General characteristics and classification; Excretion in Annelida; Evolution of coelom and metamerism.

UNIT – II Arthropoda and Onychophora **12 Hours**

General characteristics and classification (Special reference to Insecta up to orders); Vision and Respiration in Arthropoda; Metamorphosis in insects; Social life of bees and termite, Evolutionary significance of Onychopora.

UNIT – III Mollusca **06 Hours**

General characteristics and classification; Respiration in Mollusca; Torsion and Detorsion in Gastropoda; Pearl formation in bivalves.

UNIT – IV Echinodermata **05 Hours**

General characteristics and classification; Water-vascular System in Asteroidea.

Note: Outline classification up to classes to be followed from "Ruppert, Fox and Barnes (2004). Invertebrate Zoology: A Functional Evolutionary Approach". VII Edition, Cengage Learning, India.

Practical component -60 Hours

1. Study of *Aphrodite, Nereis, Heteronereis, Sabella, Serpula, Chaetopterus, Pheretima, Hirudinaria,* Trochophore larva.
2. Study of T.S. through pharynx, gizzard, and typhlosolar intestine of earthworm.
3. Study of *Limulus*, *Palamnaeus, Palaemon, Daphnia*, *Balanus*, *Sacculina*, *Cancer*, *Eupagurus*, *Scolopendra*, *Julus*, *Bombyx*, *Periplaneta,* termite, *Apis, Musca.*
4. Study of *Peripatus.*
5. Study of *Chiton, Dentalium, Pila, Doris, Helix, Unio, Patella, Ostrea, Pinctada, Sepia, Octopus, Nautilus.*
6. Study of *Pentaceros/Asterias, Ophiura, Clypeaster, Echinus, Cucumaria, Antedon*; Any two larval forms.
7. Study of mouth parts, digestive system and nervous system of *Periplaneta.* *
8. Study of the digestive system of *Pheretima*. *
9. Submit a Project Report on the larval forms in different phyla OR field study of the insect diversity.

   *Subject to UGC approval and guidelines

Essential/recommended readings

1. Ruppert, Fox and Barnes (2004). Invertebrate Zoology. VII Edition,Cengage Learning, India.
2. Pechenik, J. A. (2015). Biology of the Invertebrates. VII Edition,McGraw-Hill Education.
3. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). The Invertebrates: A New Synthesis. III Edition, Blackwell Science

Suggestive readings

1. Ruppert, E.E., Fox, R.S., Barnes, R. D. (2003). Invertebrate Zoology: A Functional Evolutionary Approach. VII Edition, Cengage Learning, India
2. Barrington, E.J.W. (2012). Invertebrate Structure and Functions. II Edition, EWP Publishers

DISCIPLINE SPECIFIC CORE COURSE– 5 (DSC-5): Fundamentals of Biomolecules

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Fundamentals of Biomolecules	04	02	0	02	Class XII pass with Biology/ Biotechnology	NIL

Learning Objectives

The learning objectives of this course are as follows:

- To provide fundamental and precise knowledge of biomolecules that play a crucial role in all processes of life and the development of diseases.
- To make the students understand the fundamental building blocks of living organisms that include carbohydrates, proteins, lipids, nucleic acids
- To apprise the students of the various functions of the molecules like providing structural integrity to the tissue-engineered constructs.
- Through this course, the students would be able to understand the physiological importance of these biomolecules.
- The enzymatic study would enable them to understand the various metabolic pathways and physiological reactions.

Learning Outcomes

By studying this course, students will be able to

- Interpret the structure-functional relationships of carbohydrates, proteins, lipids and nucleic acids.
- Understand the qualitative analysis of functional groups
- understand the properties of various biomolecules.
- appreciate the action of the enzyme and the various factors that affect their action detail.

SYLLABUS OF DSC-5

UNIT – I Carbohydrates **06 Hours**

Structure and biological importance: with emphasis on aldose, ketose, chiral centre, polarised Light, Fischer nomenclature, Haworth projection formula, mutarotation of glucose, anomers, pyranose, furanose, glycosidic linkage; reducing and non-reducing sugars: monosaccharides, disaccharides, polysaccharides and glycoconjugates.

UNIT – II Lipids **04 Hours**

Structure and Significance: Physiologically important saturated and unsaturated fatty acids, tri-acylglycerols, phospholipids, glycolipids, steroids.

UNIT – III Proteins **08 Hours**

Amino acids: Structure, classification and general properties of α-amino acids; physiological importance of essential and non-essential amino acids; proteins: bonds stabilizing protein structure; Levels of organization in protein motifs, folds and domains; Denaturation.

UNIT – IV Nucleic Acids **04 Hours**

Structure: purines and pyrimidines, nucleosides, nucleotides, nucleic acids; Cot Curves: Base pairing, Denaturation and Renaturation of DNA; Types of DNA and RNA.

UNIT – V Enzymes **08 Hours**

Nomenclature and classification, cofactors; specificity of enzyme action, Isozymes, Mechanism of enzyme action; Enzyme kinetics; factors affecting rate of enzyme-catalysed reactions; derivation of Michaelis-Menten equation, concept of K_m and V_{max}, Lineweaver-Burk plot, multi-substrate reactions, enzyme inhibition; Allosteric enzymes and their kinetics; Regulation of enzyme reaction.

Practical component – 60 Hours

1. Understanding the structures of biomolecules through ball and stick models.
2. To understand the preparation and roles of two important biological buffer systems: phosphate and bicarbonate; Preparation of buffers and determination of pH.
3. Identification of the functional groups by qualitative tests:
   a. Carbohydrates
   b. Lipids
   c. Proteins
4. Separation of amino acids by paper chromatography.
5. Study the action of salivary amylase under optimum conditions.
6. Study the effect of pH, temperature and inhibitors on the action of salivary amylase.

Essential/recommended readings

1. Nelson, D.L., Cox, M.M. (2017). Lehninger: Principles of Biochemistry (7th ed.). New York, WH: Freeman Company.
2. Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). Harper's Illustrated Biochemistry. XXVIII Edition, International Edition, The McGraw- Hill Companies Inc.

Suggestive readings

1. Stryer, L., Berg, J., Tymoczko, J., Gatto, G. (2019). Biochemistry (9th ed.). New York, WH: Freeman.
2. Voet, D., Voet. J. G. (2013). Biochemistry (4th ed.). New Jersey, John Wiley & Sons Asia Pvt. Ltd.

DISCIPLINE SPECIFIC CORE COURSE– 6 (DSC-6): Human Physiology-Control and Coordination Systems

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Human Physiology-Control and Coordination Systems	04	02	0	02	Class XII pass with Biology/ Biotechnology	NIL

Learning Objectives

The learning objectives of this course are as follows:

- The course will provide a thorough understanding of the normal body function and helps to determine the cause of disease.
- It will enable the development of new and more effective treatments and guidelines for maintaining good health.
- It will equip the students with an ability to pursue career in medical and healthcare sector, pharmaceuticals and other related areas.
- It will help in understanding how these systems interact among themselves to maintain stability or homeostasis.

Learning Outcomes

By studying this course, students will be able to:

- appreciate human physiology and have its enhanced knowledge.
- recognize and identify principal tissue structures and functions
- understand the functions of important physiological systems including the nervous system, muscular system, endocrine and reproductive system
- learn an integrative approach to understand how these separate systems interact to yield integrated physiological responses to maintain homeostasis in the body along with feedback mechanisms.
- synthesize ideas to make the connection between knowledge of physiology and real-world situations, including healthy lifestyle decisions and problems faced due to homeostatic imbalances
- perform, analyze and report on experiments and observations in physiology
- know the fundamentals and understand advanced concepts so as to develop a strong foundation that will help them to acquire skills and knowledge to pursue an advanced degree.

SYLLABUS OF DSC-6

UNIT – I Nervous System and Sense Organs **08 Hours**

Structure of neuron, resting membrane potential, origin and conduction of action potentialacross the myelinated and unmyelinated nerve fibers; Types of synapses, synaptic transmission, Neuromuscular junction.

UNIT – II Muscle Physiology **07 Hours**

Mechanism of muscle contraction; Characteristics of muscle twitch; Motor unit, summation, and tetanus.

UNIT – III Endocrine System **08 Hours**

Hormones secreted by the glands, their physiological action and the disorders related to their secretion; Classification of hormones and their regulation; Mode of hormone action- Signal transduction pathways for peptide and steroid hormones.

UNIT – IV Reproductive System **07 Hours**

Physiology of male and female reproduction– spermatogenesis, oogenesis, follicular development, steroidogenesis, implantation, pregnancy, and mammary gland development.

Practical component – 60 Hours

1. Classification, structure and functions of tissues: epithelial, connective, muscular and nervous tissue.
2. Structure, histology, types and function of bones and cartilage.
3. Classification and histological structure of muscle; ultrastructure of striated muscle.
4. Preparation of temporary mounts: Squamous epithelium, Striated muscle fibres, Nerve cells.
5. Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerk reflex).
6. Recording of simple muscle twitch with electrical stimulation (Interpretation/ Virtual).
7. Study of permanent slides of Mammalian Skin, Spinal cord, Hypothalamus, Pineal, Pituitary, Thyroid, Parathyroid, Pancreas, Adrenal, Testis and Ovary.
8. Permanent slide preparation from various tissues: Tissue fixation, block preparation, tissue sectioning, H&E staining, microscopy (Minimum three tissues; tissue can be procured from the slaughterhouse).

Essential/recommended readings

1. Tortora, G.J. and Derrickson, B.H. (2012). Principles of Anatomy and Physiology. XIII Edition, John Wiley and Sons, Inc.
2. Widmaier E, Raff H and Strang K. (2013) Vander's Human Physiology: The Mechanism of Body Functions. XIII Edition, McGraw-Hill Education.
3. Guyton, A.C. and Hall, J.E. (2011) Textbook of Medical Physiology. XII Edition, Harcourt Asia Pvt. Ltd/ W.B. Saunders Company.
4. Eroschenko, Victor P. (2012) Di Fiore's Atlas of Histology with Functional Correlations; 12th edition, CBS Publishers and Distributors Pvt. Ltd.

Suggestive readings

1. Chatterjee, C.C. (2021) Human Physiology, 14th Edition, Volume 1 & Volume II, CBS Publishers and Distributors Pvt. Ltd.
2. Kesar, S. and Vashisht, N. (2007) Experimental Physiology. Heritage Publishers.

Category-II
BSc Life Science with Zoology as one of the Core Disciplines

DISCIPLINE SPECIFIC CORE COURSE -6 (Zoo-LS-DSC-06):– Cell and Developmental Biology of Animals

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Cell and Developmental Biology of Animals Zoo-LS-DSC-06	04	02	0	02	Class XII pass	NIL

Learning Objectives

The learning objectives of this course are as follows:

- The course will help the students to learn and develop an understanding of a cell as a basic unit of life.
- The course will enable them to understand the functions of cellular organelles and how a cell carries out and regulates cellular functions.
- The course will provide the students a complete comprehension about the essential vertebrate developmental biology
- The course will help the students to understand the conundrum of **the different levels of biological complexity** by tracing them back to events at the level of genes and genomes**.**

Learning Outcomes

By studying this course, students will be able to

- Explain the structure and functions of cell organelles involved in diverse cellular processes.
- Know the evolution of different concepts in developmental biology.
- Be able to understand the process of gamete formation from stem cell population to mature ova and sperm. The students will know the differences between Spermatogenesis and Oogenesis.
- Be able to comprehend the sequence of steps leading to the fusion of gametes and learn the contribution of sperm and ova to zygote formation
- Be able to understand how polyspermy is avoided in animal kingdom.
- Learn the mechanisms underpinning cellular diversity and specificity in animals.
- Learn the methods and tools related to developmental biology help to understand different processes of embryogenesis.

SYLLABUS OF Zoo-LS-DSC-06

UNIT - I Cell Division and Differentiation 06 Hours

Types of animal cells and tissues, Mitosis, meiosis, Cell cycle regulation, Cell-cell communication, Stem cells, Differential gene expression.

UNIT- II: Scope and History of Developmental Biology 03 Hours

Historical perspective including contributions by eminent scientists and landmark experiments in the field of Developmental Biology, Concepts of Epigenesis, Preformation, Von Baer laws.

UNIT- III: Early Embryonic Development 15 Hours

Gametogenesis: Spermatogenesis and Oogenesis in mammals; Types of Eggs and Egg membranes Fertilization: External (amphibians) and Internal (mammals), Fast and slow blocks to Polyspermy; Types and Patterns of cleavage; Types of morphogenetic movements; Early development of frog and chick up to gastrulation. Fate maps

UNIT- IV: Late Embryonic Development 04 Hours

Fate of Germ Layers; Formation of neural tube, Extra-embryonic membranes in birds

UNIT- V: Post Embryonic Development 02 Hours

Metamorphic events and its hormonal regulation in amphibians.

Practical Component – 60 Hours

1. Study of the various stages of meiosis through permanent slides.
2. Frog - Study of developmental stages - whole mounts and sections through permanent slides- cleavage stages, blastula, gastrula, neurula, tail bud stage, tadpole external and internal gill stages.
3. Chick – Study of Whole Mounts of developmental stages of Chick through permanent slides (HH stages)- 13 hrs, 18hrs, 24hrs, 28hrs, 33hrs, 36hrs, 48hrs, 72hrs and 96hrs.
4. Study of the different types of placenta along with its function- through permanent slides / photomicrograph.
5. Study of various developmental stages in the life Cycle of Drosophila using stock culture/ permanent slides/ photomicrograph.
6. Visit to IVF centre/ Poultry Farm.
7. Project report on IVF Centre/ Poultry farm/ Drosophila culture/ Zebra fish culture.

Essential/recommended readings

1. Cooper, G.M., Hausman, R.E. (2019) The Cell: A Molecular Approach. VIII Edition, ASM Press and Sinauer Associates.
2. Becker, Kleinsmith, and Hardin (2018) The World of the Cell, IX Edition,Benjamin Cummings Publishing, San Francisco.
3. Gilbert, SF (2014) Developmental Biology (10th edition). Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA. ISBN : 9780878939787
4. Balinsky, B.I. (2008). An introduction to Embryology, International Thomson Computer Press.
5. Freeman and Bracegirdle (1975, 2nd Edition) "An Atlas of Embryology", Published by Heinmann.

Suggestive readings

1. De Robertis, E.D.P. and De Robertis, E.M.F. (2009) The Cell and Molecular Biology, Lippincott Williams & Wilkins, Philadelphia.
2. Karp, G. (2015). Cell and Molecular Biology: Concepts and Experiments, VIII Edition, John Wiley & Sons Inc
3. Kalthoff Klaus (2001) Analysis of Biological Development, 2nd ed. Boston, MA: Mc Graw-Hill, ISBN : 0071180788
4. Wolpert, L & Tickle, C (2011) Principles of Developmental Biology (4th edition). Oxford University Press, ISBN: 9780198792918
5. Carlson, Bruce M (1996). Patten's Foundations of Embryology, McGraw Hill, Inc. ISBN : 9780070634275

Category-IV

COMMON POOL OF GENERIC ELECTIVES (GE) COURSES OFFERED BY THE DEPARTMENT OF ZOOLOGY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

GENERIC ELECTIVES (GE-3): Economic Zoology

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Economic Zoology	**04**	**02**	**0**	**02**	**Class XII pass**	**NIL**

Learning Objectives

The learning objectives of this course are as follows:

- It deals with the application of zoological knowledge for the benefit of mankind by understanding the economy, health and welfare of humans.
- It includes culturing organisms for mass production for human use and to control or eradicate harmful ones.
- It will bring to the fore the multidisciplinary nature of Economic Zoology as it includes sericulture, apiculture, aquaculture, pisciculture and insect pests of agriculture.

Learning Outcomes

By studying this course, students will be able to

- develop an understanding of the beneficial higher and lower organisms in terms of economic prospective.
- aquatic organisms and agriculturally important insect pests based on their morphological characteristics/structures.
- develop a critical understanding of the contribution of organisms to the welfare of society.
- examine the diversity of insect pests of different orders in the agro-ecosystem and sustainable pest management strategies.

SYLLABUS OF GE-3

UNIT – I Aquaculture **05 Hours**

Definition, scope, and significance of Aquaculture, Prawn culture, Pearl culture, Edible Oyster culture.

UNIT – II Pisciculture **07 Hours**

Basic concept on mono and composite fish culture (Carp culture); Fish diseases caused by *Ichthyophthirius multifilis, Trichodinia* sp. and *Ichthyobodo* sp., symptoms and control; Maintenance of aquarium.

UNIT – III Sericulture **05 Hours**

Different species and economic importance of silkworm, Mulberry and Non-mulberry Sericulture (Eri, Muga, Tussar), Sericulture techniques.

UNIT – IV Apiculture **05 Hours**

Different species of Honeybee, types of beehives - Newton and Langstroth, Bee Keeping equipment, Methods of extraction of honey (Indigenous and Modern) and its processing, Products of apiculture industry (Honey, Bees Wax, Propolis, Royal jelly, Pollen etc.) and their uses.

UNIT – V Agricultural Crop Pest and Management **08 Hours**

Bionomics of crop pests of rice (*Leptocorisa acuta*); sugarcane (*Pyrilla perpusilla*); vegetable (*Raphidopalpa foveicollis*); and stored grain (*Corcyra cephalonica*); Pest Management Strategies (Physical, Chemical & Biological)

Practical component – 60 Hours

1. Study of aquatic organisms - prawns, oysters and fishes (*any three)* through museum specimens in the laboratory with details on their classification, distribution and specialized features.
2. Study of different species of aquarium fishes (Goldfish, Guppy, Swordtail fish) and maintenance of aquarium in lab/indoor.
3. Study of major crop pests of rice (*Leptocorisa acuta*), sugarcane (*Pyrilla perpusilla*), vegetable (*Raphidopalpa foveicollis*) and stored grain (*Corcyra cephalonica*) belonging to different orders.
4. Study of *Bombyx mori*, its life cycle and economic importance.
5. Study of the life history of honeybee, *Apis cerana indica* and *Apis mellifera* from specimen/ photographs - egg, larva, pupa, adult (queen, drone, worker)
6. Study of artificial hive (Langstroth/Newton), its various parts and beekeeping equipment.
7. Project report on life cycle of any one crop pest or on a product obtained from apiculture industry.
8. Field study/lab visit to an apiary/honey processing unit/sericulture institute/aquarium shop/fish farm/pisciculture unit.

Essential/recommended readings

1. Atwal, A.S. (1993) Agricultural Pests of India and Southeast Asia. Kalyani Publishers, New Delhi.
2. Shukla, G.S. and Upadhyay, V.B.: Economic Zoology, 4e, 2002, Rastogi.
3. D. B. Tembhare. (2017) Modern Entomology. Published by Himalaya Publishing House (ISO 9001: 2008 Certified).
4. Dawes, J. A. (1984) The Freshwater Aquarium, Roberts Royee Ltd. London.

Suggestive readings

1. S.S. Khanna and H.R. Singh. A Textbook of Fish Biology & Fisheries Published by Narendra Publishing House.3rdEdition. (ISBN13: 9789384337124)
2. Dokuhon, Z.S. (1998). Illustrated Textbook on Sericulture. Oxford & IBH Publishing Co., Pvt. Ltd. Calcutta.

GENERIC ELECTIVES (GE-4): Lifestyle Disorders

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Lifestyle Disorders	04	02	0	02	Class XII pass	NIL

Learning Objectives

The learning objectives of this course are as follows:

- The course aims to introduce the students to the concept of health, nutrition, and the factors affecting it.
- It will apprise students of the prevalence of emerging health issues affecting the quality of life.
- The course will facilitate the understanding of different physical and psychological associated disorders and their management for a healthy lifestyle.
- It highlights the important lifestyle-related disorders and describes the risks and remedies in relation to adopting a better life.

Learning Outcomes

By studying this course, students will be able to

- have a better understanding of lifestyle choices and the diseases associated with them.
- have an in-depth understanding of making better lifestyle decisions.
- learn about various techniques for preliminary diagnosis of lifestyle disorders

SYLLABUS OF GE-4

UNIT – I Introduction to Lifestyle **05 Hours**

Traditional Indian lifestyle vs modern Indian lifestyle, lifestyle diseases – definition, risk factors-erratic sleep patterns, wrong food choices, smoking, alcohol abuse, stress, lack of optimum physical activity, illicit drug use, Obesity, respiratory diseases, diet and exercise.

UNIT – II Diabetes and Obesity **05 Hours**

Types of Diabetes mellitus; Blood glucose regulation; Complications of diabetes-paediatric and adolescent obesity-weight control and BMI (Body Mass Index), Prediabetes, PCOS/PCOD.

UNIT – III Cardiovascular Diseases **06 Hours**

Coronary atherosclerosis-Coronary artery disease, Causes-Fat and lipid, Alcohol Abuse-Diagnosis, Electrocardiograph, Echocardiograph, Treatment, Exercise and Cardiac rehabilitation.

UNIT – IV Cancer **05 Hours**

Introduction to Cancer and general diagnostic methods to detect cancer; Lung Cancer, Mouth Cancer: associated lifestyle choices, symptoms and treatment.

UNIT – V Hypertension **04 Hours**

Risk factors, complications (brain, heart, eye and kidney) and management of hypertension.

UNIT – VI WHO Global action plan and Monitoring **05 Hours**

WHO Global action plan and Monitoring framework for prevention and control of non-communicable diseases, NPHCE (National Programme for the Health Care of Elderly), Fit India movement (Yoga and meditation).

Practical component – 60 Hours

1. Estimation of blood glucose (GOD/POD) by kit.
2. Calculation of BMI, waist to hip ratio, skin fold test.
3. Imaging techniques for cancer diagnosis. CT Scan, MRI, PET-CT scan. Confirmatory Biopsy.
4. Blood pressure measurement using a sphygmomanometer.
5. Study of cardiac rehabilitation- thrombolytic agents and balloon angioplasty.
6. Project Work based on Case studies related to risk factors of any ONE lifestyle disorder studied.

OR

7. To write a review of personal experience of using any of the available health or lifestyle-related applications over a period of time with some data to correlate.

Essential/recommended readings

1. James M.R, Lifestyle Medicine, 2nd Edition, CRC Press,2013,
2. Tortora, G.J. and Grabowski, S. (2006). Principles of Anatomy & Physiology. XI edition. John Wiley & Sons
3. Cooper, G.M., Hausman, R.E. (2009). The Cell: A Molecular Approach. V Edition, ASM Press and Sinauer Associates

Suggestive readings

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Harcourt Asia PTE Ltd/W.B. Saunders Company.
2. Widmaier E, Raff H and Strang K. (2013) Vander's Human Physiology: The Mechanism of Body Functions. McGraw-Hill Education 13th Edition.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

ACBR

Category-I

BSc. (HONS.) Biomedical Sciences

DISCIPLINE SPECIFIC CORE COURSE– 4 (DSC-4): Biochemistry

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Biochemistry	04	03	0	01	Class XII pass	NIL

LEARNING OBJECTIVES

The objective of this course is to effectively incorporate the fundamentals of metabolism through key biochemical pathways and make learners appreciate the requirement for the stringency of their regulation; introduce various biochemical techniques used in the characterization of the proteins and a detailed account on how enzymes function: their kinetics, regulation and inhibition.

COURSE OUTCOMES

- Students will gain an understanding of fundamental biochemical principles of metabolism of biomolecules (Carbohydrates, Proteins, Lipids and Nucleic acids) and the associated bio- energetics. They will learn the biochemical reactions in metabolic pathways and understand their interrelations, logics and patterns.

- They will also understand the role of enzymes in the biochemical reactions and the connection between biochemical defects and metabolic disorders. Students would additionally gather a firm understanding and relevance of stringent regulation of metabolic pathways.

- Having understood the structural architecture of proteins in earlier semesters, students shall learn how biological molecules (especially proteins) are characterized through various analytical techniques such as types of column chromatography methods, Polyacrylamide Gel Electrophoresis (PAGE) that are used in contemporary biochemistry research laboratories.

- Students will get a grasp on central concepts underlying enzyme catalysis, kinetics and their mechanism of action. Effects of different kinds of enzyme-inhibitors will also be learned.
- Students would learn how coenzymes assist enzymes in catalyzing biochemical reactions and what is the criterion for their classification.

- Having studied the role of enzymes that regulate metabolic pathways in the third unit, students would learn the general properties of regulatory enzymes, their activity and kinetics.

COURSE CONTENT:

Unit I: Metabolic pathways and their allosteric regulation	**(22 hrs)**
Carbohydrates- Glycolysis, Gluconeogenesis, Tricarboxylic acid cycle and their regulation, Cori cycle, Hexose monophosphate shunt. **Lipids**- Mobilization of triglycerides, Metabolism of glycerol, Biosynthesis and β-oxidation of saturated fatty acids (palmitic acid) and their regulation. Significance of ketone bodies. **Proteins**- General over view, Transamination, Deamination, Glucose-Alanine cycle, Urea cycle and its regulation. **Nucleic acid**- General overview, an outline of purine and pyrimidine metabolism. Electron transport chain, Oxidative phosphorylation and Substrate-level phosphorylation.	
Unit II: Analytical methods in protein characterization	**(08 Hours)**
Introduction to spectrophotometry & Lambert-Beer's law, Column chromatography: Ion exchange chromatography, Gel filtration and Affinity chromatography, SDS-PAGE	
Unit III: Enzymes	**(07 Hours**
Introduction to enzymes, Concept of Lock & key and 'Induced fit theory, Concept of activation energy and binding energy. Enzyme kinetics: Michaelis-Menten equation and its physiological significance. Concept of enzyme inhibition: types of inhibitors (competitive &non-competitive) and their examples.	
Unit IV: Coenzymes	**(04 Hours)**
Classification: various types and their function.	
Unit V: Regulatory Enzymes	**(04 Hours)**
General properties of allosteric enzymes. Enzyme regulation by covalent modification. Zymogens.	

PRACTICAL – 30 Hours

(Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Measurement of absorbance & %transmittance of a solution using spectrophotometer/colorimeter.

2. Preparation of standard plot and estimation of protein concentration by any one method: Biuret/Lowry/Bradford.
3. Estimation of glucose concentration by an enzymatic/non-enzymatic method.
4. Separation of biomolecules (sugar/amino acids) by thin-layer chromatography (TLC).
5. Separation of biomolecules by gel filtration/Calculation of void volume of Sephadex G-25 column, using Blue Dextran.
6. Analysis of SDS-PAGE as a separation technique (gel analysis).
7. To perform an assay of an enzyme under optimal conditions.
8. Determination of Km, Vmax and Kcat value of a given enzyme from the provided experimental data.

SUGGESTED READINGS:

- Nelson, D. L., & Cox, M. M. (2021). *Lehninger: Principles of Biochemistry* (8th ed.). Macmillan. ISBN:9781319322328
- Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology (2018). 8th ed. Hofmann A. and Clokie S.(Eds.) Cambridge University Press, Cambridge, U.K.
- Plummer, D.T. (2012). *An Introduction to Practical Biochemistry.* New Delhi, India: McGraw-Hill College.
- S. K. Sawhney / Randhir Singh. (2009): Introductory Practical Biochemistry, Narosa Publishers, ISBN-13 : 978-8173193026
- Donald Voet, Judith G. Voet (2021) Voet's Biochemistry, Adapted ed 2021, ISBN: 9789354243820.

BOOK FOR BASIC CONCEPTUAL READING

- Berg, J., Gatto, G., Stryer, L. and Tymoczko, J. L. (2019). *Biochemistry*. New York, USA: W. H. Freeman and Company.
- Devlin, (2011). *Textbook of biochemistry with clinical correlations*. UK: Wiley T & Sons.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE– 5 (DSC-5): PRINCIPLES OF GENETICS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Principles of Genetics	04	03	0	01	Class XII pass	NIL

LEARNING OBJECTIVES:

The course intends to introduce students to Mendelian principles of inheritance, deviations from Mendelian inheritance and extra-nuclear inheritance, Introduction to pedigree analysis for autosomal and X-linked traits, Understanding of differences between prokaryotic and eukaryotic genome organization, transposons, and basic cytogenetics and Understanding of mechanisms of sex determination.

COURSE OUTCOMES:

- The flavour of genomics as a progression from Mendelian genetics will be introduced to the students. They will learn about classical experiments that led to discovery of the genetic material. They will also learn the structure of DNA.
- Students will be able to explain Mendelian laws of inheritance, deviations from monohybrid ratio (incomplete dominance, codominance, multiple alleles and lethal genes) and deviations from dihybrid ratio (gene-gene interactions, linkage). They must be able to distinguish sex-linked, sex-limited and sex-influenced traits. Students must also be able to interpret patterns of inheritance for autosomal and X-linked traits from pedigrees.
- Students would learn the concept of extra-nuclear inheritance.
- Students would learn the differences in genomes of prokaryotes and eukaryotes. They would also learn about transposable genetic elements with examples from prokaryotes and eukaryotes.
- The lectures will cover details of the structure of the chromosomes, the abnormalities that commonly occur at chromosomal level. Discussion of various types of mutations at the DNA level (deletion, addition, substitution), their consequence on gene structure/product and the diseases associated with these abnormalities.
- Students wouldgain insights into genetic and environmental sex determination mechanisms.

COURSE CONTENT:

Unit I: Overview of Changing Paradigms in Genetics	05 Hours
A brief overview of how genetic principles took shape, leading to the concept of a blueprint of lifewithin the cell to the physical entity of DNA. Basic structure of DNA, salient features of the doublehelix, semi-conservative replication– Meselson and Stahl experiment. Also mention the surprises we have from genomics such as genetic variation between individuals. There are popular videos/presentations that can be used. The purpose is to ignite the curiosity of the students.	
Unit II: Concept of Genetic Inheritance	**15 Hours**
Concept of alleles, haploid and diploid status, phenotype and genotype, Mendel's laws of inheritance, dominant and recessive inheritance, test, back and reciprocal crosses with two examples each. Chromosomal theory of inheritance. Concept of linkage and crossing over,cytological proof of crossing over, genetic mapping: two and three-point cross over. Distinguishing recombination and complementation. Allelic interactions- dominance relationships- complete, incomplete and co-dominance, gene-gene interactions. Sex linked, sex-limited and sex-influencedtraits. Gathering family history, pedigree symbols and construction of pedigrees for autosomal and sex linked traits (dominant and recessive).	
Unit III: Extra Nuclear Inheritance	**05 Hours**
Criteria for extra nuclear inheritance, plastid inheritance in *Mirabilis jalapa*, kappa particles in *Paramecium*, maternal effect- snail shell coiling, cytoplasmic inheritance (mitochondria andchloroplast).	
Unit IV: Genome Organization	**07 Hours**
Organization of Genomes in prokaryotes and eukaryotes. Establishing the Central Dogma. Nucleosomes organization and assembly. Euchromatin, heterochromatin-constitutive and facultative heterochromatin. Structure and significance of polytene and lampbrush chromosomes. Transposable genetic elements: Prokaryotic transposable elements- IS elements, Composite transposons; Eukaryotic transposable elements- Ac-Ds system in maize; Uses of transposons.	
Unit V: Cytogenetics and Mutations	**08 Hours**

Chromosome: Structure- centromere and telomere, types of chromosomes based on centromere. Karyotyping- banding pattern and nomenclature (G and Q banding). Structural abnormalities (Duplication, Insertion, Deletion, Translocation-Reciprocal and Non-Reciprocal) and associated syndromes. Numerical abnormalities (Aneuploidy and Euploidy) and associated syndromes.Spontaneous and induced mutations. Types of mutations: Point (Non-sense, miss-sense, silent, frameshift, insertion, deletion). Effects on the Gene products- loss of function and gain of function.	
Unit VI: Introduction to Mechanisms of Sex Determination	**05 Hours**
Chromosomal theory of sex determination, mechanisms of sex determination, environmentalfactors and sex determination in human and *Drosophila*. Barr bodies and dosage compensation.	

PRACTICAL – 30 Hours

(Wherever wet lab experiments are not possible, the principles and concepts can bedemonstrated through any other material or medium including videos/virtual labs etc.)

1. Observation of wild type and mutant phenotypes in *Drosophila.*
2. Preparation of culture media for *Drosophila* and study different stages of the life cycle of *Drosophila.*
3. Verification of Mendelian laws through *Drosophila*/ seeds – dominant, recessive and sex-linked
4. Study of Barr bodies.
5. Karyotyping with the help of photographs (normal and abnormal karyotypes).
6. Pedigree charts of some common characters like blood group, color blindness and PTC tasting.
7. Study of diploidy in onion root tip.
8. Study of polyploidy in onion root tip by colchicine treatment.
9. Study of polytene chromosomes.

SUGGESTED READINGS:

- Klug, W. S., Cummings, M., Spencer, C. A., Palladino, M. A., Darrell K. (2019*).* 12th Edition. *Concepts of genetics.* San Francisco, NY:Pearson ISBN-13: 9780134604718.
- Snustad, D.P. and Simmons, M.J. (2019). 7th Asia Edition. *Principles of genetics.* New York, USA: John Wiley and Sons. ISBN-13: 9781119657552.
- Gardner E. J., Simmons M. J. and Snustad D. P. (2006). 8th edition *Principles of genetics.* USA. Wiley. ISBN-13: 978-8126510436.

BOOK FOR BASIC CONCEPTUAL READING

- Cooper, G. M. and Hausman, R. E. (2019). 8th Edition. *The cell: A molecular approach.* Massachusetts, USA: Sinauer Associates. ISBN-13: 978-1605358635.
- Hardin, J., Bertoni, G. P., Becker, W.M. (2017). 9th Edition. *Becker's world of the cell.*NY:Pearso. ISBN-13: 978- 0805393934.
- Karp, G., Iwasa, J., Marshall W. (2018). 8th Edition. *Karp's Cell Biology.* New Jersey, USA: Wiley. ISBN-13: 978-1119456292.
- Kornberg, A. (2005). 2nd Edition. *DNA replication.* California, USA: University Science Books. ISBN-13: 978-1891389443.
- Griffith A. J. F., Wessler S. R., Carroll S. B. and Doebley J. (2011). 9th edition. *Introduction to Genetic Analysis.* W H Freeman & Co. ISBN-13 : 978-0716768876.
- Elrod, S and Stansfield, W. (2010). 5th edition. *Schaum's Outline of Genetics.* McGraw Hill. ISBN-13: 978-0071625036

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE– 6 (DSC-6): Human Physiology and Anatomy II

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Human Physiology and Anatomy II	04	03	0	01	Class XII pass	NIL

LEARNING OBJECTIVES:

- The course curriculum is a systematic presentation of physiological concepts to ensure appropriate depth and breadth of basic functioning of the human body and its interrelations with respect to heart, lung, kidney, gonads, endocrine glands and digestive system.
- It would give students exposure of physiological concepts needed as foundations for further studies in pharmacology, pathology and pathophysiology etc.
- It would provide a base to understand body defenses and the mechanisms of deranged function of human body
- The curricular objectives are focused primarily on normal body function. Accordingly, wherever possible clinical examples have been illustrated to the underlying physiological principles.

COURSE OUTCOMES:

Having successfully completed this course, students shall be able to learn and appreciate:

- The students will learn appreciate the structure and functioning of heart, pattern and significance of blood flow in the blood vessels, heart sounds, ECG and purpose of lymph and lymphatic circulation.
- The students would correlate how structure and function of lungs are so intricately designed and how they function with its blood flow and help giving vital oxygen to body. They would develop understanding for neural control and other regulators of respiration and understand daily phenomenon like coughing, sneezing, yawning etc.
- Kidneys are vital organs and students would learn the functional anatomy of a nephron and how it contributes in removing the toxic waste from our body in from of urine. The curriculum would outline the process of micturition and abnormalities associated with it. It would also highlight the role of kidney in controlling pH of the body and preventing acidosis/alkalosis
- The students would have insight into the anatomy of the female and male reproductive systems, including their accessory structures. The student would understand the role of hypothalamic and pituitary hormones in reproductive system. Trace the route of a sperm mother cell from its production till it can fertilize an oocyte. Explain the events in the ovary prior to ovulation, development and maturation of the sex organs and the emergence of

secondary sex characteristics during puberty.

- The students would be able to integrate the role of the endocrine system to maintain homeostasis in human body. Understand the chemical composition mechanisms of hormone action, their site of production, regulation, and effects of hormones of the pituitary, thyroid, parathyroid and adrenal, glands. Hormonal regulation of the reproductive system. The role of the pancreatic endocrine cells in the regulation of blood glucose In addition the contributions of hormones released by the heart, kidneys, and other organs with secondary endocrine functions. The student would be aware of several common diseases associated with endocrine system dysfunction.

- Students would be able to understand the organs of the alimentary canal from proximal to distal, and understand their function. Identify the accessory digestive organs and their functions. Describe the histology that is four fundamental tissue layers of the digestive tract. Contrast the contributions of the enteric and autonomic nervous systems to alimentary tract functioning. Gain awareness about common dysfunctions of digestive system like constipation, gastritis, ulcers, diarrhea etc.

COURSE CONTENT:

Unit-I: Cardiovascular System	**09 Hours**
Functional Anatomy of heart, The Cardiac Cycle, Electrocardiogram. Circulatory system: Bloodvessels, hemodynamics and regulatory mechanisms, Lymphatic circulation - hemodynamics and regulation, micro-circulation	
Unit-II: Respiratory system	**09 Hours**
Functional Anatomy of the respiratory system. Mechanisms of pulmonary ventilation, alveolarventilation, gaseous exchange, transport of gases, respiratory and nervous control and regulation of respiration	
Unit-III: Renal Physiology	**06 Hours**
Body fluid and electrolytes: their balances and imbalances. Functional Anatomy of kidney,Histology of nephron and its physiology, Urine formation, renal regulation of urine volume and osmolarity, acid-base balance. Urinary bladder: structure, micturition and its regulation	
Unit-IV: Reproductive System	**06 Hours**
Structure and function of male and female reproductive organ. Function and regulation of testicularand ovarian hormones. Gametogenesis (oogenesis and spermatogenesis), fertilization, implantation, parturition and lactation, menopause and basic concepts of infertility.	
Unit-V: Endocrine System	**09 Hours**

General mechanism of hormone action, Structure, function and regulation of the following glands and their secretions: Pituitary, Hypothalamus, Thyroid, Parathyroid, Adrenal, and Pancreas. Basic concepts about hypo and hyper secretion of hormones.	
Unit-VI: Gastrointestinal system	**06 Hours**
Anatomy and histology of digestive tract, gastrointestinal physiology: General principles of gut motility secretion, digestion, absorption and assimilation. Gastrointestinal hormones: their formation and action. Physiological anatomy and functions of liver and pancreas.	

PRACTICAL – 30 Hours

(Wherever wet lab experiments are not possible, the principles and concepts can bedemonstrated through any other material or medium including videos/virtual labs etc.)

1. Physiological data acquisition based experiments (ECG).
2. Physiological data acquisition-based experiments (EMG).
3. Physiological data acquisition-based experiments (PFT).
4. Blood Pressure recordings in humans.
5. Determination of specific gravity of blood.
6. Determination of osmotic fragility of RBC.
7. To study various types of contraceptives (condoms, IUD"s, oral and injectable contraceptives)
8. To study different human organs and their sections through permanent slides. T. S. of thyroid, liver, thymus, spleen, ovary, artery, vein, capillaries, testis, pancreas, esophagus, adrenal, kidney (cortex and medulla), urinary bladder, urethra, fallopian tubes, epididymis, prostate glands, lungs, trachea, bronchioles, pituitary, heart. (Minimum 8 slides covering the systems mentioned in theory.)

SUGGESTED READINGS:

- Guyton and Hall Textbook of Medical Physiology, 14th edition (2020), J. E. Hall; W B Saunders and Company, ebook ISBN: 978-0-3236-4003-9; Hardcover ISBN: 978-0-3235-9712-8
- Human Physiology, 16th edition (2011), Stuart I. Fox; Tata McGraw Hill, ISBN10: 1260720462; ISBN13: 978-1-26-072046-4.
- Principles of Anatomy and Physiology, 16th edition (2020), Gerard J. Tortora and Bryan H. Derrickson; Wiley and Sons, ISBN: 978-1-119-66268-6. (e book), ISBN: 978-1-119-70438-

6 (for print book).

- Textbook of Practical Physiology, 9th edition (2019), CL Ghai; Jaypee Publication, ISBN-9789352705320.

BOOK FOR BASIC CONCEPTUAL READING

- Ganong's Review of Medical physiology, 26th edition (2019), K. E. Barett, S. M. Barman, S. Boitano and H. Brooks; Tata McGraw Hill, ISBN 978-1-26-012240-4 (for ebook) ISBN:978-1-26-012241-1 (for print Book)

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

Category-IV
Common Pool of Generic Electives offered by Department of Biomedical Sciences

Generic Elective -2 (GE-2): Landmark Discoveries in Science

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Landmark Discoveries in Science	04	03	0	01	Class XII pass	NIL

LEARNING OBJECTIVES:

The objective of the course is to ensure students appreciate the convenience and comfort that they have is all because of discoveries and inventions of the past. Meticulous execution of historical experiments in very little resources would also motivate them towards doing valuable research with enormous facilities that they have. The historical accounts of science provide grounds for interpretation and may be useful in arousing appreciation of science. The course would provide: Detailed analysis of classically designed and executed experiments in Life Sciences over the years. It will provide a foundation of biology by uncovering various players in the machinery of biological processes. I will also be helpful in technical, scientific analysis with historical background for a robust understanding of various discoveries. Critical analysis of the history of biology would surely help students comprehend futuristic scientific discoveries.

COURSE OUTCOMES

- Students will be able to learn how was light manipulated during the past to peer into previously invisible world—those too small or too far away to be seen by the naked eye.
- Students will learn about experiments that had fundamental contribution to our present understanding of key molecular elements of life. They will understand how to examine microbial cells and colonies, using various techniques to manipulate color, size, and contrast in ways that helped Scientists to identify species and diagnose disease.
- Studying this unit, students would come to know that there were three group of Naturalists working simultaneously to find answers to inheritance, evolution and basic composition of life.

Students will be divulged with hereditary aspects of life. They will get familiar with genes and their roles in living organisms.

- Having understood the relationship of genes and inheritance, students would find interesting to learn the mystical molecule that make up these genes. Sequential study of these experiments would step by step unravel the mystery of genetic material.
- Students at this point of course would be curious to know the structure of molecule that forms the genetic material. They would learn how the information present on DNA manifests itself as specific characteristic features and help in diversity among organisms.
- Students will be explained how the in depth knowledge about DNA became the most important tool for *in vitro* research, modification and applications thereof.
- Students will be briefed about some landmark discoveries which helped the field of medicine to grow tremendously and played a significant role in improving the overall health of the human population.
- Students can be given small projects to write discoveries done in conventional way.
- They will be required to provide a descriptive view of the topics assigned to them. Students should highlight the research topic with reference to current understanding.

COURSE CONTENT:

Unit I: View of the invisible Biology	**04 Hours**
Rudimentary microscopes to magnify objects; Use of eye glasses as simplest microscopes - Flea or fly glasses; Observing nature in the new world under lens; Book of Optics; Scientific use of Microscopes; Importance of Malphigi microscope that used field lens; Compound Microscope; Robert Hooke's observations in Micrographia; Foldscope by Manu Prakash	
Unit-II: Origin of Life – A question	**03 Hours**
Spontaneous generation versus biogenesis; Problem of spores; Microbiology and Medicine - Germ theory of Disease; Recognition of agents of infection – Koch's Postulates.	
Unit-III: Understanding Biology by observations	**04 Hours**

A) Study of evolution of life: Darwins Theory (B) Study of Inheritance of Life: classical era with contributions of Aristotle, Epicurus, and others; Modern genetics: Gregor JohannMendel, his work on pea plants, theory of Mendelian inheritance (C) Study of compositionof Life : Levels of cellular and molecular organization; Cells, tissues and organs in our body; Pioneers of chromosome studies; Discovery of nucleic acids; Nuclein verified as a distinct chemical entity; Early identification of purines and pyrimidines; building blocks of Nucleic acids and proteins; Chemistry of Nucleic acids; Levene's tetranucleotidehypothesis.	
Unit-IV: DNA as the hereditary material – An experimental view	**06 Hours**
Transformation: Classic work of Frederick Griffith; DNA as the Pneumococcal Transforming Factor; *In vitro* Transformation system; Announcement that the transformingPrinciple was DNA; Mirsky's Criticism; The Avery, MacLeod and McCarty proclamation;Additional experiments that supported DNA as the transforming principle; Hershey and Chase clinched the role of DNA as the Genetic Material	
Unit-V: Solving the puzzle of DNA structure	**07 Hours**
Early studies of diffraction of X Rays by DNA fibers – contributions of Rosalind Franklin; Use of X – rays in medicines and research; Erwin Chargaff's discovery of base complementarity in DNA; Watson and Crick model of DNA; Contribution of Linus Pauling; DNA is replicated in Semi-conservative Fashion; Deciphering the Genetic Code; One Gene One Enzyme Edict.	
Unit-VI: Technical advancements in biology	**07 Hours**
Polymerase Chain Reaction – a revolution in modern biology; DNA Manipulations using Restriction enzymes; Discovery of reverse transcriptase leading to development of RT-PCR for RNA amplification; Work of Stanley Cohen and Herbert Boyer; Advent of gene cloning - History and current applications	
Unit-VII: Research as a backbone of modern medicine	**07 Hours**

(A) Discovery of antimicrobial agents; Contribution of Joseph Lister and later by Alexander Flemming leading to Discovery of Magic bullets; (B) Control of Infectious Diseases – Variolation, mithridatism and vaccination from the view of Edward Jenner; Vaccine production strategies – with examples of BCG and SARS-CoV2 vaccines; Historical timeline of vaccination strategies;(C) Marie Curie – Use of radiation in medicine.	
Unit VIII: Project Work [On any one topic]	**07 Hours**
Study historical research papers and provide a descriptive view of research that was carriedout by Scientists as Minor Project. (A) Ancient system of medicine (B) Contribution of any one Indian Scientists in Biology (C) Contribution of any Physicists or Chemists in Biology (for topics listed above)	

PRACTICAL – 30 Hours

(Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Comparison of invisible life under the view of microscopes versus foldscope.
2. Cells as a unit of life and observation under the microscopes.
3. How do the cells divide – a view under the microscope: (mount of an onion root tip, onion bud cells or grasshopper testis).
4. Mendel's laws of inheritance – clues from nature.
5. Extraction of genomic DNA
6. Use of electric field to analyse DNA and other biomolecules.
7. Sneak Peek through the discovery of Polymerase chain reaction (PCR): Demonstration of original method and comparison with today's sophistication.
8. To test Flemming's hypothesis that the mold killed the bacteria.
9. Group Discussion on Research Topics assigned to students.

SUGGESTED READINGS:

- Watson, J. D. (2011) *The Double Helix – A personal account of the discovery of the structure of DNA*. Scribner. ISBN 9780743219174.
- Cooper, G. M. and Hausman, R. E. (2013). 6th Edition. *The cell: A molecular approach*. Massachusetts, USA: Sinauer Associates. ISBN-13:978-1605351551
- Karp, G. (2013). 7th Edition. *Cell and molecular biology: Concepts and experiments.* New Jersey,USA: Wiley Publishers. ISBN-978-0470483374.
- Cox, M. M. Doudna J. A. and Donnell, M. O. (2012). 1st Edition. *Molecular Biology: Principles and Practice.* London, United Kingdom: W H Freeman & Co Publishers, ISBN-13: 978-0-716- 7998-8.
- Watson, J. D. Baker T. A. Bell, S. P. Gann, A. Levine, M. and Losick, R. (2013). 7th Edition. *Molecular Biology of the Gene.* New York, United States: Cold Spring Harbor Laboratory Press, ISBN-13: 978-0-321-76243-6.

BOOK FOR BASIC CONCEPTUAL READING

- Alberts, B et al. (2014). 6th edition. *Molecular Biology of the Cell*. W. W. Norton & Company.ISBN-13 : 978-0815345244
- Bryson, B. (2003) *A short history of nearly everything.* Transworld Publishers. London W5 5SA.A Random House Group Company. ISBN: 9780552997041.
- Lodish H et al. (2003). 5th Revised edition. *Molecular Cell Biology*. W.H.Freeman& Co Ltd;ISBN-13 : 978-0716743668
- Green, M. R. and Sambrook, J. (2012). 4th Edition. *Molecular Cloning: A Laboratory Manual,* New York, United States: Cold Spring Harbor Laboratory Press, ISBN-13:978-1936113422.
- Kornberg, A. (2005). 2nd Edition. *DNA Replication.* California, United States: University ScienceBooks, ISBN-13: 978-1891389443.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

Note: *The Generic Electives courses offered in Semester-I are also open for Semester-II*

DEPARTMENT OF GEOLOGY

Category-I
BSc (Hons.) Geology

DISCIPLINE SPECIFIC CORE COURSE -4 (DSC-4) – : Structural Geology

Credit distribution, eligibility and pre-requisites of the course:

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Structural Geology (DSC-4)	4	3	0	1	12th Pass	---

Learning Objectives
Structural geology essentially deals with the geometry, kinematics and dynamics of deformation of rocks. In response to the instability of the lithosphere produced by complex plate tectonic movements, continuous and discontinuous deformation takes place within the rocks in solid or semi-solid state, at different scales and at different depths, which manifests in a variety of complex structures in these rocks.

Learning outcomes
On completion of the course, the student should be able to:
i. Identify the different geometric features of deformation, different types of deformation-induced structures,
ii. Understand basic techniques of measurement of different parameters in deformed rocks, and
iii. Understand a glimpse of the underlying deformation processes and mechanisms.

SYLLABUS OF DSC-4

UNIT – I (09 Hours)
Introduction to Structure and Topography: Understanding a topographic map; Effects of topography on structural features: Rule of V; Planar and linear structures; Concept of dip and strike, trend and plunge.

UNIT – II (09 Hours)
Stress and strain in rocks: Concept of rock deformation: Definition of Stress and Strain, Strain ellipses of different types and their geological significance. Mohr circle for stress and its application.

UNIT – III (08 Hours)
Folds: Fold morphology; Geometric and genetic classification of folds; Introduction to the mechanics of folding: Buckling, Bending, Flexural slip and flow folding.

UNIT – IV (08 Hours)
Foliation and lineation: Description and origin of foliations: axial plane cleavage and its tectonic significance; different types of foliations: crenulation cleavage, disjunctive cleavage,

salty cleavage, schistosity, gneissosity etc. Description and origin of lineation and relationship with major structures; stretching lineation and its relationship with strain.

UNIT – V (08 Hours)

Fractures and faults: Geometric and genetic classification of fractures and faults; Effects of faulting on the outcrops; Geologic/geomorphic criteria for recognition of faults and Mechanism of faulting: Anderson theory of faulting. Joints – different types of joints and their geological significance – columnar joint, pinnate joint, plumose structure.

UNIT – VI (03 Hours)

Shear Zones: Introduction, Geometry, strain profile, shear zones rocks and shear sense indicators.

Practical component - 30 Hours

Basic idea of topographic contours, Topographic sheets of various scales.
Structural contouring and 3-point problems of dip and strike
Introduction to Geological maps: Drawing profile sections and interpretation of geological maps of different complexities.
Exercises of stereographic projections

Essential/recommended readings

Fossen, H. (2010) Structural Geology. Cambridge University Press
Park, R. G. (2004) Foundations of Structural Geology. Chapman & Hall.

Suggestive readings

Fossen, H. (2010) Structural Geology. Cambridge University Press.
Davis, G. R. (1984) Structural Geology of Rocks and Region. John Wiley
Billings, M. P. (1987). Structural Geology, 4th edition, Prentice-Hall.
Park, R. G. (2004) Foundations of Structural Geology. Chapman & Hall.
Pollard, D. D. (2005) Fundamental of Structural Geology. Cambridge University Press.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 5 (DSC-5): Igneous Petrology

Credit distribution, Eligibility and Prerequisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Igneous Petrology (DSC-5)	4	3	0	1	12th Pass	----

Learning Objectives
To develop an understanding of the types of magma as well as types of igneous rocks. Magma generation in relation to different geodynamic settings and its relation with the petrological and geochemical features of the igneous rocks.

Learning outcomes
On completion of the course, the student should be able to:
a) Identify the igneous rocks using petrographical, mineralogical and geochemical indices
b) Determine the evolution of igneous rocks in relation to different geodynamic settings

SYLLABUS OF DSC- 5

UNIT – I (09 Hours)
Introduction to Igneous Petrology: Scope of Igneous petrology, classification of Igneous rocks, igneous textures, igneous structures.

UNIT – II (09 Hours)
Introduction to silicate melts and magmas: Physical properties of magma, the ascent of magmas, magmatic differentiation.

UNIT – III (09 Hours)
Introduction to Igneous Phase diagrams. The phase rule, the lever rule, Two Component systems involving melt: Binary system with a Eutectic, Binary system with a peritectic, Binary system thermal barrier, Binary system with solid solution.

UNIT – IV (09 Hours)
The chemistry of igneous rocks. Modal mineralogy, normative mineralogy, variation diagrams based on major elements, trace elements and their significance, application of radioactive isotopes in igneous petrology.

UNIT – V (09 Hours)
Introduction to igneous environments: Basalts and mantle structure, Magma generation and igneous rocks associated with various plate tectonic settings.

Practical component : 30 Hours

Study of important igneous rocks in hand specimens and thin sections- granite, granodiorite, diorite, gabbro, anorthosites, ultramafic rocks, basalts, andesites, trachyte, rhyolite.
Classification of Igneous Rocks.
Plotting and interpretation of variation diagrams.
Igneous rock occurrences in Indian context.

Essential/recommended readings

Winter, J. D. (2014). Principles of igneous and metamorphic petrology. Pearson.
Wilson, M. (1989) Igneous Petrogenesis, Springer-Verlag Berlin Heidelberg.
Frost, B. R. and Frost, C. D., (2013) Essentials of Igneous and Metamorphic Petrology Cambridge University Press.

Suggestive readings (if any)

Frost, B. R. and Frost, C. D., (2013) Essentials of Igneous and Metamorphic Petrology Cambridge University Press.
Philpotts, A., & Ague, J. (2009). Principles of igneous and metamorphic petrology. Cambridge University Press.
Winter, J. D. (2014). Principles of igneous and metamorphic petrology. Pearson.
Rollinson, H. R. (2014). Using geochemical data: evaluation, presentation, interpretation. Routledge.
Sen, G. (2014) Petrology Principles and Practice, Springer-Verlag Berlin Heidelberg
Bose M.K. (1997). Igneous Petrology.
Wilson, M. (1989) Igneous Petrogenesis, Springer-Verlag Berlin Heidelberg.

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DISCIPLINE SPECIFIC CORE COURSE– 6 (DSC-6): Elements of Geochemistry

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Elements of Geochemistry DSC-6	**4**	**3**	**0**	**1**	**12th Pass**	**---**

Learning Objectives

The Learning Objectives of this course are as follows:

- To develop an understanding of the chemical nature of the earth and other planetary material and relate mineralogy, geochemistry and bulk chemistry.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Students will be able to appreciate the field of geochemistry and understand the properties of the elements - Nucleosynthesis; Cosmochemistry; Principles of isotope geochemistry; Solid earth geochemistry: Core, Mantle, Crust. Near-surface geochemical environment, Chemical weathering of minerals and rocks. Examples of instrumentation, data collection and analyses

SYLLABUS OF DSC-6

UNIT – I (09 Hours)

The abundance of elements in the cosmos, solar system and earth. Meteorites, distribution of elements in core, mantle, crust.

UNIT – II (12 Hours)

Introduction to properties of elements: periodic table, chemical bonding, states of matter and atomic environment of elements, geochemical classification of elements, the concept of elemental fractionation.

UNIT – III (12 Hours)

Geochemistry of igneous rocks: geochemical variability of magma and its products. Near-surface geochemical environment: Chemical weathering of minerals and rocks.

UNIT – IV (12 Hours)

Introduction to isotope geology: use of stable and radiogenic isotopes in earth science.

Practical component: - 30 Hours

- Geochemical analysis of geological materials (analytical methods, concept of normalization)
- Geochemical variation diagrams, common geochemical plots, and their interpretations.
- Basic idea about handling and interpretation of isotope data.

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Essential/recommended readings

Mason, B (1986). Principles of Geochemistry. 3^{rd} Edition, Wiley New York.
Faure, G., 1986. Principle of Isotope Geology, J. Wiley & Sons.

Suggestive readings

Mason, B (1986). Principles of Geochemistry. 3^{rd} Edition, Wiley New York.
Rollinson H. (2007). Using geochemical data evaluation. Presentation and interpretation. 2^{nd} Edition. Publisher Longman Scientific & Technical.
Walther John, V., 2009 Essentials of geochemistry, student edition. Jones and Bartlett Publishers
Albarede, F, 2003. An introduction to geochemistry. Cambridge University Press.
Faure, G., 1986. Principle of Isotope Geology, J. Wiley & Sons.
Geochemistry by William M White, Wiley-Blackwell (2013).

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

CATEGORY-IV

COMMON POOL OF GENERIC ELECTIVES (GE) COURSES OFFERED BY DEPARTMENT OF GEOLOGY

GENERIC ELECTIVES (GE-2): Physics & Chemistry of Earth

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Physics & Chemistry of Earth (GE-2)	4	3	1	0	Class-XII	---

Learning Objectives

To develop an understanding of the surface and internal structure of the Earth and its mineralogy and chemistry; To equip the students about the present and past processes operative in shaping the physical and chemical make-up of the planet Earth

Learning outcomes

After completion of this course students will learn about:

- Physical, mineralogical and chemical structure of the earth
- Major surface features and their evolution through time
- Concept of geological time and its determination
- Earth's magneitc field, its short term and long term variation and its application
- Physical and chemical evolution of earth through time

SYLLABUS OF GE-2 – (Lecture- 45 Hours)

UNIT – I

Earth: surface features: Continents, continental margins, oceans
Earth's materials: Rocks and Minerals

UNIT – II

Earth's interior - variation of physical parameters and seismic wave velocity inside the earth, major sub divisions and discontinuities. Depth-wise mineralogical variation in the Earth. Concepts of Isostasy; Airy and Pratt Model. Core and Mantle: Seismological and other geophysical constraints. The geodynamo - Convection in the mantle. Plate Tectonics. Types of plate margins and their Dynamics.

UNIT – III

Elements of Earth's magnetism: Secular variation and westward drift. Solar activity and magnetic disturbance. Paleomagnetism

UNIT – IV

Elements: Origin of elements/nucleosynthesis. Abundance of the elements in the solar system/planet Earth. Geochemical classification of elements. Earth accretion and early differentiation. Isotopes and their applications in understanding Earth processes.

UNIT – V

Isotopes: Radiogenic and Stable. Radiogenic isotopes and their applications
Stable isotope fractionation. Oxygen isotopes. Sublithospheric Mantle (Mineralogy/phase transitions) Concept of mantle heterogeneity

UNIT – VI

Low-temperature geochemistry; surface and near-surface processes

Essential/recommended readings

- Holmes, A. (1992). Principles of Physical Geology, 1992, Chapman and Hall.
- Anderson, G. M. (1996). Thermodynamics of natural systems. John Wiley & Sons Inc.
- Condie, K.C. (2016) Earth as an evolving planetary system (3rd Edn.) Elsevier

Suggestive readings

- Holmes, A., Principles of Physical Geology, 1992, Chapman and Hall
- Condie, K.C. Plate Tectonics and Crustal Evolution, Pargamon Press, 1989.
- Krauskopf, K. B., & Dennis, K. Bird, 1995, Introduction to Geochemistry. McGraw-Hill
- Faure, G. Principles and Applications of Geochemistry, 2/e (1998), Prentice Hall, 600 pp.
- Anderson, G. M. (1996). Thermodynamics of natural systems. John Wiley & Sons Inc.
- Steiner, E. (2008). The chemistry maths book. Oxford University Press.
- Yates, P. (2007) Chemical calculations. 2nd Ed. CRC Press.
- Condie, K.C. (2016) Earth as an evolving planetary system (3rd Edn.) Elsevier

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DEPARTMENT OF PHYSICS & ASTROPHYSICS

Category-I

BSc. (H) Physics

DISCIPLINE SPECIFIC CORE COURSE – 4: MATHEMATICAL PHYSICS II

Course title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Mathematical Physics II DSC – 4	4	2	0	2	Class XII Pass	-----

LEARNING OBJECTIVES

The emphasis of course is on applications in solving problems of interest to physicists. The course will also expose students to fundamental computational physics skills enabling them to solve a wide range of physics problems. The skills developed during course will prepare them not only for doing fundamental and applied research but also for a wide variety of careers.

LEARNING OUTCOMES

After completing this course, student will be able to,

- Use curvilinear coordinates to solve problems with spherical and cylindrical symmetries
- Represent a periodic function by a sum of harmonics using Fourier series
- Obtain power series solution of differential equation of second order with variable coefficient using Frobenius method
- Understand the properties and applications of Legendre polynomials
- Learn about gamma and beta functions and their applications
- In the laboratory course, the students will learn to
    - Apply appropriate numerical method to solve selected physics problems both using user defined and in-built functions from Scilab/ Python
    - Solve non-linear equations
    - Perform least square fitting of the data taken in physics lab by user defined functions.
    - Interpolate a data by polynomial approximations
    - Generate and plot a function by its series representation
    - Generate and plot Legendre polynomials and verify their properties.
    - Numerically integrate a function and solve first order initial value problems numerically.

SYLLABUS OF DSC – 4

UNIT – I **(13 Hours)**

Orthogonal Curvilinear Coordinates: Orthogonal Curvilinear Coordinates. Scale factors, element of area and volume in spherical and cylindrical coordinate Systems. Derivation of Gradient, Divergence, Curl and Laplacian in Spherical and Cylindrical Coordinate Systems

Fourier Series: Periodic functions, Orthogonality of sine and cosine functions, Convergence of Fourier series and Dirichlet Conditions (Statement only), Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients, Even and odd functions and their Fourier expansions (Fourier Cosine Series and Fourier Sine Series), Parseval's Identity.

UNIT – II **(17 Hours)**

Frobenius Method and series solution of Differential Equations: Singular Points of Second Order Linear Differential Equations and their importance, Frobenius method for finding series solution and its applications, Legendre Differential Equations and its solution. Properties of Legendre Polynomials: Rodrigues Formula, Generating Function, Orthogonality of Legendre Polynomials, Simple recurrence relations, Expansion of function in a series of Legendre Polynomials.

Some Special Integrals: Beta and Gamma Functions and relation between them, Expression of Integrals in terms of Gamma and Beta Functions.

References:

Essential Readings:

1) Mathematical Methods for Scientists and Engineers, D. A. McQuarrie, 2003, Viva Book.
2) Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.
3) Essential Mathematical Methods, K. F. Riley and M. P. Hobson, 2011, Cambridge Univ. Press.
4) Vector Analysis and Cartesian Tensors, D. E. Bourne and P. C. Kendall, 3 Ed., 2017, CRC Press.
5) Vector Analysis, Murray Spiegel, 2nd Ed., 2017, Schaum's Outlines Series.
6) Fourier analysis: With Applications to Boundary Value Problems, Murray Spiegel, 2017, McGraw Hill Education.
7) Differential Equations, George F. Simmons, 2006, Tata McGraw-Hill.
8) Mathematical Methods for Physicists, G. B. Arfken, H. J. Weber, F. E. Harris, 7 Ed., 2013, Elsevier.

Additional Readings:

1) Introduction to Electrodynamics, Chapter 1, David J. Griffiths, 4 Ed., 2017, Cambridge University Press.
2) The Feynman Lectures on Physics, Volume II, Feynman, Leighton and Sands, 2008, Narosa Publishing House.
3) Advanced Engineering Mathematics, D. G. Zill and W. S. Wright, 5 Ed., 2012, Jones and

Bartlett Learning.
4) Introduction to Vector Analysis, Davis and Snider, 6 Ed., 1990, McGraw Hill.
5) Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.
6) Mathematical Physics, A. K. Ghatak, I. C. Goyal and S. J. Chua, 2017, Laxmi Publications Private Limited.

PRACTICAL COMPONENT – 60 Hours

The aim of this laboratory is not just to teach computer programming and numerical analysis but to emphasize its role in solving problems in Physics. The course will consist of practical sessions and lectures on the related theoretical aspects of the laboratory. Assessment is to be done not only on the programming but also on the basis of formulating the problem.

- Every student must perform at least 12 programs covering each unit.
- The list of recommended programs is suggestive only. Students should be encouraged to do more practice. Emphasis should be given to formulate a physics problem as mathematical one and solve by computational methods.
- The implementation can be either in Python/ C++/ Scilab.

Unit 1: Root Finding: Bisection, Newton Raphson and secant methods for solving roots of equations, Convergence analysis.
Recommended List of Programs (At least two):
(a) Determine the depth up to which a spherical homogeneous object of given radius and density will sink into a fluid of given density.
(b) Solve transcendental equations like $\alpha = \tan(\alpha)$.
(c) To approximate nth root of a number up to a given number of significant digits.

Unit 2: Least Square fitting (At least one): Algorithm for least square fitting and its relation to maximum likelihood for normally distributed data.
a) Make a function for least square fitting, use it for fitting given data (*x, y*) and estimate the parameters a, b as well as uncertainties in the parameters for the following cases.
   i. Linear $(y = ax + b)$
   ii. Power law $(y = ax^b)$
   iii. Exponential $(y = ae^{bx})$
b) Weighted least square fitting of given data (*x, y*) with known error/uncertainty-values using user defined function.

Unit 3: Generating and plotting of a function using series representation (At least one):
a) To approximate the elementary functions (e.g. exp(*x*), sin(*x*), cos(*x*), ln(1+*x*), etc.) by a finite number of terms of Taylor's series and discuss the truncation error. To plot the function as well the nth partial sum of its series for various values of *n* on the same graph and visualise the convergence of series.
b) Generating and plotting Legendre Polynomials using series expansion and verifying recurrence relation

Unit 4: **Interpolation:** Concept of Interpolation, Lagrange form of interpolating polynomial, Error estimation, optimal points for interpolation.

Recommended List of Programs (At least one)

(a) Write program to determine the unique polynomial of a degree n that agrees with a given set of $(n+1)$ data points (x_i, y_i) and use this polynomial to find the value of y at a value of x not included in the data.

(b) Generate a tabulated data containing a given number of values $(x_i, f(x_i))$ of a function f(x) and use it to interpolate at a value of x not used in table.

Unit 5: **Numerical Integration:** Newton Cotes Integration methods (Trapezoidal and Simpson rules) for definite integrals, derivation of composite formulae for these methods and discussion of error estimation.

Recommended List of Programs (At least three)

(a) Given acceleration at equidistant time values, calculate position and velocity and plot them.

(b) Use integral definition of ln(x) to compute and plot ln(x) in a given range. Use trapezoidal, Simpson and Gauss quadrature methods and compare the results.

(c) Verify the rate of convergence of the composite Trapezoidal and Simpson methods by approximating the value of a given definite integral.

(d) Verify the Orthogonality of Legendre Polynomials.

(e) To evaluate the Fourier coefficients of a given periodic function (e.g. square wave, triangle wave, half wave and full wave rectifier etc.). To plot the function as well the nth partial sum of its series for various values of n on the same graph and visualise the convergence of series. Study of Gibbs phenomenon.

(f) Verify the properties of Dirac Delta function using its representation as a sequence of functions.

Unit 6: Numerical Solutions of Ordinary Differential Equations: Euler, modified Euler, and Runge-Kutta (RK) second and fourth order methods for solving first order initial value problems (IVP) and system of first order differential equations,

Recommended List of Programs (At least two)

(a) Solve given first order differential equation (Initial value problems) numerically using Euler RK2 and RK4 methods and apply to the following physics problems:
   i. Radioactive decay
   ii. Current in RC and LR circuits with DC source
   iii. Newton's law of cooling

(b) Write a code to compare the errors in various numerical methods learnt by solving a first order IVP with known solution.

(c) Solve a system of first order IVP numerically using Euler and Runge-Kutta methods. Application to physical problems.

References (for Laboratory work):

1) Documentation at the Python home page (https://docs.python.org/3/) and the tutorials there (https://docs.python.org/3/tutorial/).
2) Documentation of NumPy and Matplotlib: https://numpy.org/doc/stable/user/ and https://matplotlib.org/stable/tutorials/
3) Computational Physics, Darren Walker, 1st Edn., Scientific International Pvt. Ltd (2015).
4) Elementary Numerical Analysis, K. E. Atkinson, 3rd Edn., 2007, Wiley India Edition.
5) An Introduction to Computational Physics, T. Pang, Cambridge University Press (2010).
6) Introduction to Numerical Analysis, S. S. Sastry, 5th Edn., 2012, PHI Learning Pvt. Ltd.
7) Applied numerical analysis, Cutis F. Gerald and P. O. Wheatley, Pearson Education, India (2007).
8) Numerical Recipes: The art of scientific computing, William H. Press, Saul A. Teukolsky and William Vetterling, Cambridge University Press; 3rd edition (2007)
9) Computational Problems for Physics, R. H. Landau and M. J. Páez, 2018, CRC Press.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 5: ELECTRICITY AND MAGNETISM

Course title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Electricity and Magnetism DSC – 5	4	3	0	1	Class XII Pass	----

LEARNING OBJECTIVES

This course reviews the concepts of electromagnetism learnt at school from a more advanced perspective and goes on to build new concepts. The course covers static and dynamic electric and magnetic fields due to continuous charge and current distributions respectively.

LEARNING OUTCOMES

After completing this course, student will be able to,

- Apply Coulomb's law to line, surface, and volume distribution of charges.
- Apply Gauss's law of electrostatics to distribution of charges
- Solve boundary value problems using method of images
- Understand the concept of electric polarization and bound charges in dielectric materials
- Understand and calculate the vector potential and magnetic field of arbitrary current distribution
- Understand the concept of bound currents and magnetic susceptibility in magnetic materials
- Understand the impact of time-varying magnetic and electric fields in order to comprehend the formulation of Maxwell's equations.

SYLLABUS OF DSC – 5

UNIT – I **(15 Hours)**

Electric Field and Electric Potential for continuous charge distributions: Electric field due to a line charge, surface charge and volume charge, Divergence of electric field using the Dirac Delta function, Curl of electric field, Electric field vector as negative gradient of scalar potential, Ambiguities of electric potential, Differential and integral forms of Gauss's Law, Application of Gauss's law to various charge distributions having spherical, cylindrical and planar symmetries.

Boundary Value Problems in Electrostatics: Formulation of Laplace's and Poisson equations, First and second uniqueness theorems, Solutions of Laplace and Poisson equations in one dimension using spherical and cylindrical coordinate systems and solutions in three-dimensional using Cartesian coordinates applying separable variable technique, Electrostatic boundary conditions for conductors and capacitors.

UNIT – II **(11 Hours)**

Special techniques for the calculation of Potential and Field: The Method of Images is applied to a system of a point charge and finite continuous charge distribution (line charge and surface charge) in the presence of (i) a plane infinite sheet maintained at constant potential, and (ii) a sphere maintained at constant potential.

Electric Field in Matter: Polarization in matter, Bound charges and their physical interpretation, Field inside a dielectric, Displacement vector **D**, Gauss' law in the presence of dielectrics, Boundary conditions for **D**, Linear dielectrics, electric susceptibility and dielectric constant, Idea of complex dielectric constant due to varying electric field, Boundary value problems with linear dielectrics

UNIT – III **(19 Hours)**

Magnetic Field: Divergence and curl of magnetic field **B**, Magnetic field due to arbitrary current distribution using Biot-Savart law, Integral and differential forms of Ampere's law, Vector potential and its ambiguities, Coulomb gauge and possibility of making vector potential divergence less, Vector potential due to line, surface and volume currents using Poisson equations for components of vector potential.

Magnetic Properties of Matter: Magnetization vector, Bound currents, Magnetic intensity, Differential and integral form of Ampere's Law in the presence of magnetised materials, Magnetic susceptibility and permeability of diamagnetic, paramagnetic and ferromagnetic materials.

Electrodynamics: Faraday's law, Lenz's law, Inductance and electromotive force, Ohm's law ($\vec{J} = \sigma\vec{E}$), Energy stored in a magnetic field, Continuity equation, Displacement current and displacement current density, Basic introduction to Maxwell's equations in electromagnetism.

References:

Essential Readings:

1) Introduction to Electrodynamics, D. J. Griffiths, 3rd Edn., 1998, Benjamin Cummings
2) Schaum's Outlines of Electromagnetics by J. A. Edminister and M. Nahvi
3) Fundamentals of Electricity and Magnetism, Arthur F. Kip, 2nd Edn.1981, McGraw-Hill.
4) Electromagnetic Fields and Waves, Paul Lorrain and Dale Corson, 1991, W. H. Freeman.
5) Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education
6) Electricity and Magnetism, Tom Weideman, University of California Davis. [url: https://zhu.physics.ucdavis.edu/Physics9C-C_2021/Physics%209C_EM%20by%20Tom%20Weideman.pdf]

Additional Readings:

1) Feynman Lectures Vol. 2, R. P. Feynman, R. B. Leighton, M. Sands, 2008, Pearson Education

2) Electricity, Magnetism and Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw
3) Electricity and Magnetism, J. H. Fewkes and J. Yarwood, Vol. I, 1991, Oxford Univ. Press.
4) Problems and Solutions in Electromagnetics (2015), Ajoy Ghatak, K Thyagarajan and Ravi Varshney.

PRACTICAL – 30 Hours

Every student must perform at least five experiments.

1) Magnetic field variation along the axis of a circular coil and in a Helmholtz coil ($(r > a, r = a$ and $r < a)$. Here, 'a' is radius of coil and 'r' is distance between the coils).
2) **B**-**H** curves for soft and hard ferromagnetic materials and comparison of their coercivity, retentivity and saturation magnetization for same applied magnetic field.
3) Measurement of field strength **B** and its variation in a solenoid (determine d**B**/dx)
4) Measurement of current and charge sensitivity of ballistic galvanometer
5) Measurement of critical damping resistance of ballistic galvanometer
6) Determination of a high resistance by leakage method using ballistic galvanometer
7) Measurement of self-inductance of a coil by Anderson's Bridge
8) Measurement of self-inductance of a coil by Owen's Bridge
9) To determine the mutual inductance of two coils by the Absolute method

References (for Laboratory Work):

1) Advanced Practical Physics for students, B. L. Flint and H. T. Worsnop, 1971, Asia Publishing House
2) A Text Book of Practical Physics, I. Prakash and Ramakrishna, 11th Ed., 2011, Kitab Mahal
3) Advanced Level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
4) Engineering Practical Physics, S. Panigrahi and B. Mallick, 2015, Cengage Learning
5) Practical Physics, G. L. Squires, 2015, 4th Edition, Cambridge University Press

DISCIPLINE SPECIFIC CORE COURSE – 6: ELECTRICAL CIRCUIT ANALYSIS

Course title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Electrical Circuit Analysis DSC – 6	4	2	0	2	Class XII pass	----

LEARNING OBJECTIVES

This course covers the basic circuit concepts in a systematic manner which is suitable for analysis and design. It aims at study and analysis of electric circuits using network theorems and two-port parameters.

LEARNING OUTCOMES

At the end of the course the student will be able to,

- Understand the basic concepts, basic laws and methods of analysis of DC and AC networks and their difference
- Solve complex electric circuits using network theorems.
- Discuss resonance in series and parallel circuits and also the importance of initial conditions and their evaluation.
- Evaluate the performance of two port networks.

SYLLABUS OF DSC – 6

THEORY COMPONENT

Unit 1: (8 Hours)

Circuit Analysis: Ideal voltage source, real voltage source, current source, Kirchhoff's current law, Kirchhoff's voltage law, node analysis, mesh analysis, Star and Delta conversion

DC Transient Analysis: Charging and discharging with initial charge in RC circuit, RL circuit with initial current, time constant, RL and RC Circuits with source

Unit 2: (12 Hours)

AC Circuit Analysis: Sinusoidal voltage and current, Definitions of instantaneous, peak to peak, root mean square and average values, form factor and peak factor (for half-rectified and full-rectified sinusoidal wave, rectangular wave and triangular wave), voltage-current relationship in resistor, inductor and capacitor, phasor, complex impedance, power in AC circuits, sinusoidal circuit analysis for RL, RC and RLC Circuits, resonance in series and parallel RLC Circuits (Frequency Response, Bandwidth, Quality Factor), selectivity, application of resonant circuits

Unit 3: (10 Hours)
Network Theorems: Principal of duality, Superposition theorem, Thevenin theorem, Norton theorem, Their applications in DC and AC circuits with more than one source, Maximum Power Transfer theorem for AC circuits, Reciprocity Theorem, Millman's Theorem, Tellegen's theorem
Two Port Networks: Impedance (Z) Parameters, Admittance (Y) Parameters, Transmission Parameters, Impedance matching

References:
Essential Readings:
1) Electric Circuits, S. A. Nasar, Schaum's Outline Series, Tata McGraw Hill (2004)
2) Essentials of Circuit Analysis, Robert L. Boylestad, Pearson Education (2004)
3) Electrical Circuits, M. Nahvi and J. Edminister, Schaum's Outline Series, Tata McGraw-Hill (2005)
4) Fundamentals of Electric Circuits, C. Alexander and M. Sadiku, McGraw Hill (2008)
5) Principles of Electric Circuits, Thomas L. Floyd, 9/e (2016)

Additional Readings:
1) Network analysis, M. E. Van Valkenburg, Third edition, Prentice Hall
2) Network, Lines and Fields, John D. Ryder, Pearson Ed. II, 2015.
3) Electrical Circuits, K. A. Smith and R. E. Alley, 2014, Cambridge University Press

PRACTICAL COMPONENT – 60 Hours

Every student must perform at least seven experiments from the following list of experiments
1) Verification of Kirchoff's Law.
2) Verification of Superposition Theorem by using d.c. and a.c. voltage source
3) Verification of Norton's theorem.
4) Verification of Thevenin's Theorem and Maximum Power Transfer Theorem by using d.c. and a.c. voltage source
5) Determination of unknown capacitance using de Sauty's Bridge
6) Determination of time constant of RC and RL circuit
7) Study of frequency response of RC circuit
8) Study of frequency response of a parallel LCR Circuit and determination of its resonant frequency, impedance at resonance, quality factor and bandwidth.
9) Explore electrical properties of matter using Arduino:
    a. To study the characteristics of a series RC Circuit.
    b. To study the response curve of a series LCR circuit and determine its resonant frequency, impedance at resonance, quality factor and bandwidth

References (for Laboratory Work):

1) A Textbook of Electrical Technology, B. L. Thareja, A. K. Thareja, Volume II, S. Chand
2) Fundamentals of Electric Circuits, C. Alexander and M. Sadiku, McGraw Hill (2008)
3) Electric Circuits, S. A. Nasar, Schaum's Outline series, Tata McGraw Hill (2004)
4) Electrical Circuits, K. A. Smith and R.E. Alley, 2014, Cambridge University Press
5) Electrical Circuit Analysis, K. Mahadevan and C. Chitran, 2nd Edition, 2018, PHI Learning Pvt. Ltd.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

Category II

B. Sc. Physical Science with Physics as one of the Core Discipline

DISCIPLINE SPECIFIC CORE COURSE (PHYSICS DSC - 2): ELECTRICITY AND MAGNETISM

Course Title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Electricity and Magnetism Physics DSC 2	4	2	0	2	Class XII pass	----

LEARNING OBJECTIVES

This course reviews the concepts of electricity and magnetism learnt at school from a more advanced perspective and goes on to build new concepts. The course covers static and dynamic electric and magnetic fields, and the principles of electromagnetic induction. It also includes analysis of electrical circuits and introduction of network theorems. The students will be able to apply the concepts learnt to several real world problems.

LEARNING OUTCOMES

At the end of this course, students will be able to,

- Understand Gauss' law, Coulomb's law for the electric field, and apply them to systems of point charges as well as line, surface, and volume distributions of charges. Also to use the knowledge to solve some simple problems
- Express electric current and capacitance in terms of electric field and electric potential.
- Calculate the force experienced by a moving charge in a magnetic field
- Determine the magnetic force generated by a current carrying conductor
- Have brief idea of magnetic materials, understand the concept of electromagnetic induction, solve problems using Faraday's and Lenz's laws

In the laboratory course, students will be able to measure resistance (high and low), voltage, current, self and mutual inductance, capacitor, strength of magnetic field and its variation, study different electric circuits.

SYLLABUS OF PHYSICS DSC – 2

THEORY COMPONENT

Unit 1: (10 Hours)

Electrostatics: Electric field, electric flux, Gauss' theorem in electrostatics, applications of Gauss' theorem (linear, plane and spherical charge distribution), line integral of electric field, electric potential due to a point charge, electric potential and electric field of a dipole and charged disc, capacitance due to parallel plates and spherical condenser. Electrostatic energy of system of charge (charged sphere), dielectric medium, dielectric polarization, displacement vector, Gauss' theorem in dielectrics, parallel plate capacitor filled with dielectric.

Unit 2: (8 Hours)

Magnetostatics: Magnetic force between current elements and definition of magnetic field **B**, Biot-Savart's law and its applications (current carrying straight conductor, current carrying circular coil, current carrying solenoid), divergence and curl of magnetic field, Ampere's circuital law, magnetic properties of materials (magnetic intensity, magnetic induction, permeability, magnetic susceptibility), brief introduction of dia-, para- and ferro magnetic materials

Unit 3: (7 Hours)

Electromagnetic Induction: Faraday's laws of electromagnetic induction, Lenz's law, self-inductance of single coil, mutual inductance of two coils, energy stored in magnetic field. Maxwell`s equations and equation of continuity of current, displacement current

Unit 4: (5 Hours)

DC Circuits: Review of Kirchhoff's Voltage and Current Laws, Thevenin theorem, Norton theorem, Superposition theorem, Maximum Power Transfer theorem.

References:

Essential Readings:

1) Fundamentals of Electricity and Magnetism, Arthur F. Kip, 2nd Edn.1981, McGraw-Hill.
2) Electricity and Magnetism, J. H. Fewkes and J. Yarwood. Vol. I, 1991, Oxford Univ. Press
3) Electricity and Magnetism, D. C. Tayal, 1988, Himalaya Publishing House.
4) Fundamentals of Electromagnetics, M. A. W. Miah, 1982, Tata McGraw Hill
5) Introduction to Electrodynamics, D. J. Griffiths, 3rd Edn, 1998, Benjamin Cummings.

Additional Readings:

1) Electricity and Magnetism, Berkeley Physics Course, Edward M. Purcell, 1986, McGraw-Hill Education.
2) Problems and Solutions in Electromagnetics, Ajoy Ghatak, K Thyagarajan and Ravi Varshney.
3) University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

4) Schaum's Outline of Electric Circuits, J. Edminister and M. Nahvi, 3rd Edn., 1995, McGraw Hill.

PRACTICAL COMPONENT – 60 Hours

The teacher is expected to give basic idea and working of various instruments and circuits related to different experiments. Students should also be given knowledge of recording and analyzing experimental data.
Every student should perform at least 06 experiments from the following list of experiments.

1) To use a multimeter for measuring resistances, a.c and d.c voltages, d.c. current, capacitance and for checking electrical fuses.
2) Ballistic Galvanometer:
    a) Measurement of charge and current sensitivity
    b) Measurement of critical damping resistance
    c) Determine a high resistance by leakage method
    d) Determine self-inductance of a coil by Rayleigh's Method.
3) To compare capacitances using de Sauty's bridge.
4) Measurement of field strength B and its variation in a Solenoid
5) To study the Characteristics of a Series RC Circuit.
6) To study a series LCR circuit and determine its resonant frequency and quality factor.
7) To study a parallel LCR circuit and determine its anti-resonant frequency and quality factor
8) To determine a low resistance by Carey Foster bridge.
9) To verify the Thevenin, superposition and maximum power transfer theorems
10) To verify Norton theorem

References (for Laboratory Work):

1) Advanced Practical Physics for Students, B. L. Flint and H. T. Worsnop, 1971, Asia Publishing House.
2) Engineering Practical Physics, S. Panigrahi and B. Mallick, 2015, Cengage Learning India Pvt. Ltd.
3) A Textbook of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.
4) Practical Physics, G. L. Squires, 2015, 4th Edition, Cambridge University Press
5) Advanced Level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

Category II

(Physical Science Courses (with Electronics) for Undergraduate Programme of study with Physics and Electronics discipline as Core Disciplines)

DISCIPLINE SPECIFIC CORE COURSE (PHYSICS DSC - 3): ELECTRICITY AND MAGNETISM

Course Title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Electricity and Magnetism Physics DSC 3	4	2	0	2	Class XII pass	----

LEARNING OBJECTIVES

This course reviews the concepts of electricity and magnetism learnt at school from a more advanced perspective and goes on to build new concepts. The course covers static and dynamic electric and magnetic fields, and the principles of electromagnetic induction. It also includes analysis of electrical circuits and introduction of network theorems. The students will be able to apply the concepts learnt to several real world problems.

LEARNING OUTCOMES

At the end of this course, students will be able to,

- Understand Gauss' law, Coulomb's law for the electric field, and apply them to systems of point charges as well as line, surface, and volume distributions of charges. Also to use the knowledge to solve some simple problems
- Express electric current and capacitance in terms of electric field and electric potential.
- Calculate the force experienced by a moving charge in a magnetic field
- Determine the magnetic force generated by a current carrying conductor
- Have brief idea of magnetic materials, understand the concept of electromagnetic induction, solve problems using Faraday's and Lenz's laws

In the laboratory course, students will be able to measure resistance (high and low), voltage, current, self and mutual inductance, capacitor, strength of magnetic field and its variation, study different electric circuits.

SYLLABUS OF PHYSICS DSC – 3

THEORY COMPONENT

Unit 1: (10 Hours)
Electrostatics: Electric field, electric flux, Gauss' theorem in electrostatics, applications of Gauss' theorem (linear, plane and spherical charge distribution), line integral of electric field, electric potential due to a point charge, electric potential and electric field of a dipole and charged disc, capacitance due to parallel plates and spherical condenser. Electrostatic energy of system of charge (charged sphere), dielectric medium, dielectric polarization, displacement vector, Gauss' theorem in dielectrics, parallel plate capacitor filled with dielectric.

Unit 2: (8 Hours)
Magnetostatics: Magnetic force between current elements and definition of magnetic field **B**, Biot-Savart's law and its applications (current carrying straight conductor, current carrying circular coil, current carrying solenoid), divergence and curl of magnetic field, Ampere's circuital law, magnetic properties of materials (magnetic intensity, magnetic induction, permeability, magnetic susceptibility), brief introduction of dia-, para- and ferro magnetic materials

Unit 3: (7 Hours)
Electromagnetic Induction: Faraday's laws of electromagnetic induction, Lenz's law, self-inductance of single coil, mutual inductance of two coils, energy stored in magnetic field. Maxwell`s equations and equation of continuity of current, displacement current

Unit 4: (5 Hours)
DC Circuits: Review of Kirchhoff's Voltage and Current Laws, Thevenin theorem, Norton theorem, Superposition theorem, Maximum Power Transfer theorem.

References:
Essential Readings:

1) Fundamentals of Electricity and Magnetism, Arthur F. Kip, 2nd Edn.1981, McGraw-Hill.
2) Electricity and Magnetism, J. H. Fewkes and J. Yarwood, Vol. I, 1991, Oxford Univ. Press
3) Electricity and Magnetism, D. C. Tayal, 1988, Himalaya Publishing House.
4) Fundamentals of Electromagnetics, M. A. W. Miah, 1982, Tata McGraw Hill
5) Introduction to Electrodynamics, D. J. Griffiths, 3rd Edn, 1998, Benjamin Cummings.

Additional Readings:

1) Electricity and Magnetism, Berkeley Physics Course, Edward M. Purcell, 1986, McGraw-Hill Education.
2) Problems and Solutions in Electromagnetics, Ajoy Ghatak, K Thyagarajan and Ravi Varshney

3) University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
4) Schaum's Outline of Electric Circuits, J. Edminister and M. Nahvi, 3rd Edn., 1995, McGraw Hill.

PRACTICAL COMPONENT – 60 Hours

The teacher is expected to give basic idea and working of various instruments and circuits related to different experiments. Students should also be given knowledge of recording and analyzing experimental data.
Every student should perform at least 06 experiments from the following list of experiments.

1) To use a multimeter for measuring resistances, a.c and d.c voltages, d.c. current, capacitance and for checking electrical fuses.
2) Ballistic Galvanometer:
    e) Measurement of charge and current sensitivity
    f) Measurement of critical damping resistance
    g) Determine a high resistance by leakage method
    h) Determine self-inductance of a coil by Rayleigh's Method.
3) To compare capacitances using de Sauty's bridge.
4) Measurement of field strength B and its variation in a Solenoid
5) To study the Characteristics of a Series RC Circuit.
6) To study a series LCR circuit and determine its resonant frequency and quality factor.
7) To study a parallel LCR circuit and determine its anti-resonant frequency and quality factor
8) To determine a low resistance by Carey Foster bridge.
9) To verify the Thevenin, superposition and maximum power transfer theorems
10) To verify Norton theorem

References (for Laboratory Work):

1) Advanced Practical Physics for Students, B. L. Flint and H. T. Worsnop, 1971, Asia Publishing House.
2) Engineering Practical Physics, S. Panigrahi and B. Mallick, 2015, Cengage Learning India Pvt. Ltd.
3) A Textbook of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.
4) Practical Physics, G. L. Squires, 2015, 4th Edition, Cambridge University Press
5) Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers

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DISCIPLINE SPECIFIC CORE COURSE (PHYSICS DSC - 4): LINEAR AND DIGITAL INTEGRATED CIRCUITS

Course Title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Linear and Digital Integrated Circuits Physics DSC 4	4	2	0	2	Class XII pass	----

LEARNING OBJECTIVES

This paper aims to provide the basic knowledge of linear and digital electronics. It discusses about the operational amplifier and its applications. Boolean algebra and combinational logic circuits are also discussed.

LEARNING OUTCOMES

At the end of this course, students will be able to achieve the following learning outcomes.

- To understand Op-Amp basics and its various applications.
- To become familiar with logic gates and boolean algebra theorems.
- To understand the minimization techniques for designing a simplified logic circuit.
- To design a half adder, full adder, half-subtractor, and full-subtractor.
- To understand the working of data processing circuits, multiplexers, de-multiplexers, decoders and encoders.
- To become familiar with the working of flip-flop circuits, its working and applications.

SYLLABUS OF PHYSICS DSC – 4

THEORY COMPONENT

Unit 1: (8 Hours)

Operational Amplifiers (Black box approach): Characteristics of an ideal and practical Operational Amplifier (IC 741), Open and closed loop configuration, CMRR, Slew Rate and the concept of Virtual Ground.

Applications of Op-Amps: (1) Inverting and non-inverting amplifiers, (2) Summing and Difference Amplifier, (3) Differentiator, (4) Integrator, (5) Wein bridge oscillator, (6) Comparator, and (7) Active low pass and high pass Butter worth filter (1st order only).

Unit 2: (6 Hours)
Logic Gates and Boolean algebra: Truth Tables of OR, AND, NOT, NOR, NAND, XOR, XNOR, Basic postulates and fundamental theorems of Boolean algebra.
Combinational Logic Analysis and Design: Standard representation of logic functions (SOP), Minimization Techniques (Karnaugh map minimization up to 4 variables for SOP).

Unit 3: (6 Hours)
Arithmetic Circuits: Half and Full Adder, Half and Full Subtractor, 4-bit binary Adder/Subtractor
Data processing circuits: Multiplexers, De-multiplexers, Decoders, Encoders

Unit 4: (5 Hours)
Sequential Circuits: SR, D, and JK Flip-Flops. Race-around conditions in JK Flip-Flop. Master-slave JK Flip-Flop.
Shift registers: Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel in-Parallel-out Shift Registers (only up to 4 bits). Ring Counter.

Unit 5: (5 Hours)
Counters (4 bits): Asynchronous counter, Synchronous Counter.
D-A and A-D Conversion: 4 bit binary weighted and R-2R D-A converters, A-D conversion characteristics, successive approximation ADC.

References:
Essential Readings:
1) Op-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall
2) Operational Amplifiers and Linear ICs, David A. Bell, 3rd Edition, 2011, Oxford University Press.
3) Digital Principles and Applications, A. P. Malvino, D. P. Leach and Saha, 8th Ed., 2018, Tata McGraw
4) Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill
5) Digital Fundamentals, Thomas L. Flyod, Pearson Education Asia (1994).
6) Digital Principles, R. L. Tokheim, Schaum's outline series, Tata McGraw- Hill (1994).

PRACTICAL COMPONENT – 60 Hours

Every student should perform at least 04 experiments each from section A, B and C

Section A: Op-Amp. Circuits (Hardware design)
1) To design an inverting and non-inverting amplifier using Op-amp (741,351) for dc voltage of given gain.
2) To design inverting and non-inverting amplifier using Op-amp (741,351) and study their frequency responses
3) To add two dc voltages using Op-Amp in inverting and non-inverting mode.
4) To design a precision Differential amplifier of given I/O specification using Op-amplifier.

5) To investigate the use of an op-amp as an Integrator.
6) To investigate the use of an op-amp as a Differentiator.
7) To design a Wien bridge oscillator for given frequency using an Op-Amplifier.
8) Design a Butter-worth Low Pass active Filter (1st order) and study frequency response.
9) Design a Butter-worth High Pass active Filter (1st order) and study frequency response.
10) Design a digital to analog converter (DAC) of given specifications.

Section B: Digital circuits (Hardware design)

1) (a) To design a combinational logic system for a specified Truth Table.
   (b) To convert Boolean expression into logic circuit & design it using logic gate ICs.
   (c) To minimize a given logic circuit.
2) Half Adder and Full Adder.
3) Half Subtractor and Full Subtractor.
4) 4 bit binary adder and adder-subtractor using Full adder IC.
5) To design a seven segment decoder.
6) To build Flip-Flop (RS, D-type and JK) circuits using NAND gates.
7) To build JK Master-slave flip-flop using Flip-Flop ICs.
8) To build a Counter using D-type/JK Flip-Flop ICs and study timing diagram.
9) To make a Shift Register (serial-in and serial-out) using D-type/JK Flip-Flop ICs.

Section C: SPICE/MULTISIM simulations for electronic circuits and devices

1) To verify the Thevenin and Norton Theorems.
2) Design and analyze the series and parallel LCR circuits.
3) Design the inverting and non-inverting amplifier using an Op-Amp of given gain.
4) Design and Verification of op-amp as integrator and differentiator.
5) Design the 1st order active low pass and high pass filters of given cutoff frequency.
6) Design a Wein`s Bridge oscillator of given frequency.
7) Design clocked SR and JK Flip-Flop`s using NAND Gates.
8) Design 4-bit asynchronous counter using Flip-Flop ICs.

References (For Laboratory Work):

1) Fundamentals of Digital Circuits, Anand Kumar, 4th Edn, 2018, PHI Learning.
2) Digital Computer Electronics, A. P. Malvino, J.A. Brown, 3rd Edition, 2018, Tata McGraw Hill Education.
3) Digital Electronics, S. K. Mandal, 2010, 1st edition, Tata McGraw Hill.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

Category-IV

COMMON POOL OF GENERIC ELECTIVES (GE) COURSES
OFFERED BY THE DEPARTMENTS

Course Title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Electricity and Magnetism GE – 11	4	3	0	1	Class XII pass	NIL

LEARNING OBJECTIVES

This course begins with theorems of network analysis which are required to perform the associated experiments in the laboratory. Then course delves into the elementary vector analysis, an essential mathematical tool for understanding static electric field and magnetic field. By the end of the course, the student should appreciate Maxwell's equations.

LEARNING OUTCOMES

At the end of this course the student will be able to,

- Apply Coulomb's law to line, surface, and volume distributions of charges.
- Apply Gauss's law of electrostatics to distribution of charges
- Understand the effects of electric polarization and concepts of bound charges in dielectric materials
- Understand and calculate the vector potential and magnetic field of arbitrary current distribution
- Understand the concept of bound currents and ferromagnetism in magnetic materials

SYLLABUS OF GE – 11

THEORY COMPONENT

Unit 1: (15 Hours)

Network Analysis: Superposition, Thevenin, Norton theorems and their applications in DC and AC circuits with more than one source, Maximum Power Transfer theorem for AC circuits
Mathematical Preliminaries: Concept of scalar and vector fields, Gradient of a scalar field, Divergence and curl of vector fields and their physical interpretation, Conservative forces and Laplace and Poisson equations.
Concept of a line integral of a scalar and vector field, surface integral of vector fields and volume integral, Gauss's theorem, Stoke's theorem.

Unit 2: (15 Hours)

Electric Field and Electric Potential for continuous charge distributions: Electric field due to a line charge, surface charge and volume charge distributions, Electric field vector as negative gradient of scalar potential, Ambiguities of Electric potential, Differential and integral forms of Gauss's Law, Applications of Gauss's Law to various charge distributions with spherical, cylindrical and planar symmetries, Uniqueness theorem

Electric Field in Matter: Bound charges due to polarization and their physical interpretation. Average electric field inside a dielectric, Electric Field in spherical and cylindrical cavities of a dielectric, Displacement vector and its boundary conditions, Gauss' Law in the presence of dielectrics, Linear dielectrics: electric susceptibility and dielectric constant, Boundary value problems with linear dielectrics.

Unit 3: (15 Hours)

Magnetic Field: Divergence and curl of magnetic field B, Magnetic field due to arbitrary current distribution using Biot-Savart law, Ampere's law, integral and differential forms of Ampere's Law, Vector potential and its ambiguities.

Magnetic Properties of Matter: Magnetization vector, Bound Currents, Magnetic Intensity, Differential and integral form of Ampere's Law in the presence of magnetised materials, Magnetic susceptibility and permeability, Ferromagnetism (Hund's rule)

Electrodynamics: Faraday's Law, Lenz's Law, inductance, Electromotive force, Ohm's Law ($\vec{J} = \sigma\vec{E}$), Energy stored in a Magnetic Field. Charge Conservation, Continuity equation, Differential and integral forms of Maxwell's equations in matter.

References:

Essential Readings:

1) Introduction to Electrodynamics, D. J. Griffiths, 4th Edn., 2015, Pearson Education India Learning Private Limited.
2) Schaum's Outlines of Electromagnetics, M. Nahvi and J. A. Edminister, 2019, McGraw-Hill Education.
3) Electromagnetic Fields and Waves, Paul Lorrain and Dale Corson, 1991, W. H. Freeman.
4) Electricity and Magnetism, Edward M. Purcell, 1986, McGraw-Hill Education
5) Network, Lines and Fields, John D. Ryder, 2nd Edn., 2015, Pearson.
6) Introductory Circuit Analysis, R. Boylestead, 2016, Pearson.
7) Electricity and Magnetism, Tom Weideman, University of California Davis. [url: https://zhu.physics.ucdavis.edu/Physics9C-C_2021/Physics%209C_EM%20by%20Tom%20Weideman.pdf]

Additional Readings:

1) Feynman Lectures Vol. 2, R. P. Feynman, R. B. Leighton, M. Sands, 2008, Pearson Education
2) Electricity, Magnetism and Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw
3) Fundamentals of Physics, Resnick, Halliday and Walker 10/e, 2013, Wiley

PRACTICAL COMPONENT- 30 Hours

Learning Outcome:

- To understand working of Arduino Microcontroller System
- To use Arduino to measure time, count events and time between events
- To use Arduino to measure voltage/current/resistance
- To use Arduino to measure various physical parameters like magnetic field

Unit I (Mandatory): Arduino Programming
Introduction to Arduino Microcontroller platform. Getting acquainted with the Arduino IDE and Basic Sketch structure. Digital Input and output. Measuring time and events. Measuring analog voltage. Generating analog voltage using Pulse Width Modulation. Serial communication and serial monitor. Programming using Interrupts.

Unit II: Exploring electrical properties of matter using Arduino (at least one experiment)
- To study the characteristics of a series RC Circuit.
- To study response curve of a Series LCR circuit and determine its (a) Resonant frequency, Impedance at resonance, (c) Quality factor Q, and (d) Band width.
- Diode Characteristics:
    - To study characteristics of diode and estimate Boltzman constant.
    - To study characteristics of LED and estimate Planck's constant

Unit III: Exploring magnetic properties of matter using Arduino
- To verify Faraday's law and Lenz's law by measuring induced voltage across a coil subjected to varying magnetic field. Also, estimate dipole moment of the magnet.

Unit IV: DC and AC Bridges (at least one experiment)
- To compare capacitances using de Sauty Bridge
- To determine a Low Resistance by Carey - Foster Bridge

Unit V: Network Theorems
(at least one experiment)
- To verify the Thevenin and Norton theorems
- To verify the Superposition, and Maximum Power Transfer Theorems

References (for Laboratory Work):
1) Advanced Practical Physics for students, B. L. Flint and H. T. Worsnop, 1971, Asia Publishing House.
2) Engineering Practical Physics, S. Panigrahi and B. Mallick, 2015, Cengage Learning India Pvt. Ltd.
3) A Text Book of Practical Physics, I. Prakash and Ramakrishna, 11th Ed.2011, Kitab Mahal
4) Practical Physics, G. L. Squires, 2015, 4th Edition, Cambridge University Press

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVE (GE - 12): THERMAL PHYSICS

Course Title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course	Department offering the course
		Lecture	Tutorial	Practical			
Thermal Physics GE – 12	4	3	0	1	Class XII pass	NIL	Physics and Astrophysics

LEARNING OBJECTIVES

This course will review the basic concepts of thermodynamics, kinetic theory of gases with a brief introduction to statistical mechanics. The primary goal is to understand the applications of fundamental laws of thermodynamics to various systems and processes. This coursework will also enable the students to understand the connection between the macroscopic observations of physical systems and microscopic behaviour of atoms and molecule through statistical mechanics.

LEARNING OUTCOMES

At the end of this course, students will,

- Get an essence of the basic concepts of thermodynamics, the first and the second law of thermodynamics, the concept of entropy and the associated theorems, the thermodynamic potentials and their physical interpretations. They are also expected to learn Maxwell's thermodynamic relations.
- Know the fundamentals of the kinetic theory of gases, Maxwell-Boltzman distribution law, mean free path of molecular collisions, viscosity, thermal conductivity and diffusion.
- Learn about the black body radiations, Stefan- Boltzmann's law, Rayleigh-Jean's law and Planck's law and their significances.
- Learn the basics of quantum statistical distributions, viz., the Bose-Einstein statistics and the Fermi-Dirac statistics.

In the laboratory course, the students are expected to measure of Planck's constant using black body radiation, determine Stefan's constant, coefficient of thermal conductivity of a bad conductor and a good conductor, determine the temperature coefficient of resistance, study variation of thermo-emf across two junctions of a thermocouple with temperature etc.

SYLLABUS OF GE – 12

THEORY COMPONENT

Unit 1: (12 Hours)

Laws of Thermodynamics: Fundamental basics of Thermodynamic system and variables, Zeroth Law of Thermodynamics and temperature, First law and internal energy, various thermodynamical processes, Applications of First Law: general relation between C_P and C_V, work done during various processes, Compressibility and Expansion Coefficient, reversible and irreversible processes, Second law: Kelvin-Planck and Clausius statements, Carnot engine, Carnot cycle and theorem, basic concept of Entropy, Entropy changes in reversible and irreversible processes, Clausius inequality, Entropy-temperature diagrams.

Unit 2: (08 Hours)

Thermodynamical Potentials: Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Maxwell's relations and applications - Clausius Clapeyron Equation, Expression for $(C_P – C_V)$, C_P/C_V, TdS equations, energy equations for ideal gases.

Unit 3: (8 Hours)

Kinetic Theory of Gases: Derivation of Maxwell's law of distribution of velocities and its experimental verification, Mean free path (zeroth order only), Transport Phenomena: Viscosity, Conduction and Diffusion (for vertical case).

Unit 4: (7 Hours)

Theory of Radiation: Blackbody radiation, Spectral distribution, Derivation of Planck's law, Deduction of Wien's law, Rayleigh-Jeans Law, Stefan Boltzmann Law and Wien's displacement law from Planck's law.

Unit 5: (10 Hours)

Statistical Mechanics: Macrostate and Microstate, phase space, Entropy and Thermodynamic Probability, Maxwell-Boltzmann law, Fermi-Dirac distribution law - Bose-Einstein distribution law - comparison of three statistics.

References:

Essential Readings:

1) A Treatise on Heat, Meghnad Saha, and B. N. Srivastava, 1969, Indian Press.
2) Heat and Thermodynamics, M. W. Zemasky and R. Dittman, 1981, McGraw Hill.
3) Thermodynamics, Kinetic theory and statistical thermodynamics, F. W. Sears and G. L. Salinger. 1988, Narosa.
4) Thermal Physics, A. Kumar and S. P. Taneja, 2014, R. Chand Publications.
5) Thermal Physics: S. C. Garg, R. M. Bansal and C.K. Ghosh, 2nd Ed. Tata McGraw-Hill.

Additional Readings:

1) Concepts in Thermal Physics: Blundell and Blundell, 2nd Ed. 2009, Oxford Univ. Press.

2) An Introduction to Thermal Physics: D. Schroeder 2021, Oxford Univ. Press (earlier published by Pearsons).
3) Heat, Thermodynamics and Statistical Physics, Brij Lal, N. Subrahmanyam and P. S. Hemne, S. Chand and Company.

PRACTICAL COMPONENT- 30 Hours

- Sessions on the construction and use of specific measurement instruments and experimental apparatuses used in the thermal physics lab, including necessary precautions.
- Sessions on the review of experimental data analysis, sources of error and their estimation in detail, writing of scientific laboratory reports including proper reporting of errors.
- Application to the specific experiments done in the lab.

Every student must perform at least four experiments from the following list.
1) To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
2) Measurement of Planck's constant using black body radiation.
3) To determine Stefan's Constant.
4) To determine the coefficient of thermal conductivity of Cu by Searle's Apparatus.
5) To determine the coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method by steam or electrical heating.
6) To determine the temperature co-efficient of resistance by Platinum resistance thermometer.
7) To study the variation of thermos-emf across two junctions of a thermocouple with temperature.

References (For Laboratory Work):
1) Advanced Practical Physics for students, B. L. Flint and H. T. Worsnop, 1971, Asia Publishing House.
2) A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal.
3) A Laboratory Manual of Physics for Undergraduate Classes, D. P. Khandelwal, 1985, Vani Publication.
4) Practical Physics, G. L. Squires, 2015, 4th Edition, Cambridge University Press.
5) An Advanced Course in Practical Physics: D. Chattopadhyay and P. C. Rakshit, New Central Book Agency

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVE (GE - 13): MODERN PHYSICS

Course Title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Modern Physics GE – 13	4	3	0	1	Class XII pass	NIL

LEARNING OBJECTIVES

The objective of this course is to teach the physics foundation necessary for learning various topics in modern physics which are crucial for understanding atoms, molecules, photons, nuclei and elementary particles. These concepts are also important to understand phenomena in Laser physics, condensed matter physics and astrophysics.

LEARNING OUTCOMES

After getting exposure to this course, the following topics would have learnt,

- Main aspects of the inadequacies of classical mechanics as well as understanding of the historical development of quantum mechanics, laying the foundation of modern physics.
- Formulation of Schrodinger equation and the idea of probability interpretation associated with wave-functions.
- The spontaneous and stimulated emission of radiation, optical pumping and population inversion, Basic lasing action.
- The properties of nuclei like density, size, binding energy, nuclear force and structure of atomic nucleus, liquid drop model and mass formula.
- Radioactive decays like alpha, beta, gamma decay. Neutrino, its properties and its role in theory of beta decay.
- Fission and fusion: Nuclear processes to produce nuclear energy in nuclear reactor and stellar energy in stars.

In the laboratory course, the students will get opportunity to measure Planck's constant, verify photoelectric effect, and determine e/m of electron and work function of a metal. They will also find wavelength of Laser sources by single and double slit experiment, wavelength and angular spread of He-Ne Laser using plane diffraction grating.

SYLLABUS OF GE – 13

THEORY COMPONENT

Unit 1: (10 Hours)

Origin of Modern Physics: Blackbody Radiation: Failure of explanation from classical theory; Planck's idea of a quantum; Quantum theory of Light: Photo-electric effect and Compton scattering, de Broglie wavelength and matter waves; Davisson-Germer experiment; Wave description of particles by wave packets, Group and Phase velocities and relation between them.

Unit 2: (10 Hours)

Problems with Rutherford model: Instability of atoms and observation of discrete atomic spectra; Bohr's quantization rule and atomic stability; calculation of energy levels for hydrogen-like atoms and their spectra.

Uncertainty principle: Gamma ray microscope thought experiment; Wave-particle duality leading to Heisenberg uncertainty principle; Impossibility of an electron being in the nucleus, Energy-time uncertainty principle; origin of natural width of emission lines

Unit 3: (10 Hours)

Basics of quantum Mechanics: Two-slit interference experiment with photons and electrons; Concept of wave functions, linearity and superposition, Time independent Schrodinger wave equation for non-relativistic particles; Momentum and Energy operators; physical interpretation of a wave function, probabilities, normalization and probability current densities in one dimension. Problem: One dimensional infinitely rigid box. An application: Quantum dot.

Unit 4: (05 Hours)

X-rays: Ionizing Power, X-ray Diffraction, Bragg's Law. Critical Potentials, X-rays-Spectra: Continuous and Characteristic X-rays, Moseley's Law.

LASERs: Properties and applications of Lasers. Emission (spontaneous and stimulated emissions) and absorption processes, Metastable states, components of a laser and lasing action.

Unit 5: (10 Hours)

Nuclear Physics: Size and structure of atomic nucleus and its relation with atomic weight; Nature of nuclear force, Stability of the nucleus; N-Z graph, Drip line nuclei, Binding Energy, Liquid Drop model: semi-empirical mass formula.

Radioactivity: Different equilibrium, Alpha decay; Beta decay: energy released, spectrum and Pauli's prediction of neutrino; Gamma ray emission, energy-momentum conservation:

Fission and fusion: Mass deficit and generation of energy; Fission: nature of fragments and emission of neutrons. Fusion and thermonuclear reactions driving stellar evolution (brief qualitative discussions only).

References:

Essential Readings:

1) Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.
2) Modern Physics by R. A. Serway, C. J. Moses and C. A. Moyer, 3rd edition, Thomson Brooks Cole, 2012.
3) Modern Physics for Scientists and Engineers by S. T. Thornton and A Rex, 4th edition, Cengage Learning, 2013.
4) Concepts of Nuclear Physics by B. L. Cohen, Tata McGraw Hill Publication, 1974.
5) Quantum Mechanics: Theory and Applications, Ajoy Ghatak and S. Lokanathan, Laxmi Publications, 2019

Additional Readings:

1) Six Ideas that Shaped Physics: Particle Behave like Waves, T.A. Moore, 2003, McGraw Hill.
2) Thirty years that shook physics: the story of quantum theory, George Gamow, Garden City, NY: Doubleday, 1966.
3) New Physics, ed. Paul Davies, Cambridge University Press (1989).
4) Quantum Theory, David Bohm, Dover Publications, 1979.
5) Lectures on Quantum Mechanics: Fundamentals and Applications, eds. A. Pathak and Ajoy Ghatak, Viva Books Pvt. Ltd., 2019
6) Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn., 2002, Wiley.
7) Basic ideas and concepts in Nuclear Physics: An introductory approach by K Heyde, third edition, IOP Publication, 1999.

PRACTICAL COMPONENT – 30 Hours

- Sessions on the construction and use of specific measurement instruments and experimental apparatuses used in the modern physics lab, including necessary precautions.
- Sessions on the review of experimental data analysis, sources of error and their estimation in detail, writing of scientific laboratory reports including proper reporting of errors.
- Application to the specific experiments done in the lab.

Every student must perform at least 06 experiments from the following list of experiments.

1) Measurement of Planck's constant using black body radiation and photo-detector.
2) Photo-electric effect: estimate Planck's constant using graph of maximum energy of photo-electrons versus frequency of light.
3) To determine work function of material of filament of directly heated vacuum diode.
4) To determine the Planck's constant using LEDs, using at least 4 LEDs.
5) To determine the wavelength of H-alpha emission line of Hydrogen atom.
6) To determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet.
7) To setup the Millikan oil drop apparatus and determine the charge of an electron.
8) To show the tunneling effect in tunnel diode using I-V characteristics.
9) To determine the wavelength of laser source using diffraction of single slit.

10) To determine wavelength and angular spread of He-Ne laser using plane diffraction grating.
11) To determine the wavelength of laser source using diffraction of double slits.

References (for Laboratory Work):

1) Advanced Practical Physics for students, B. L. Flint and H. T. Worsnop, 1971, Asia Publishing House.
2) Advanced Level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
3) A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.
4) Practical Physics, G. L. Squires, 2015, 4th Edition, Cambridge University Press.
5) B. Sc. Practical Physics, Geeta Sanon, R. Chand, 2016.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVE (GE - 14): INTRODUCTORY ASTRONOMY

Course Title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical		
Introductory Astronomy GE – 14	4	3	1	0	Class XII pass	NIL

LEARNING OBJECTIVES

This course is meant to introduce undergraduate students to the wonders of the Universe. Students will understand how astronomers over millennia have come to understand mysteries of the universe using laws of geometry and physics, and more recently chemistry and biology. They will be introduced to the Indian contribution to astronomy starting from ancient times up to the modern era. They will learn about diverse set of astronomical phenomenon, from the daily and yearly motion of stars and planets in the night sky which they can observe themselves, to the expansion of the universe deduced from the latest observations and cosmological models. Students will also be introduced to internet astronomy and the citizen science research platform in astronomy. The course presupposes school level understanding of mathematics and physics.

LEARNING OUTCOMES

After completing this course, student will gain an understanding of,

- Different types of telescopes, diurnal and yearly motion of astronomical objects, astronomical coordinate systems and their transformations
- Brightness scale for stars, types of stars, their structure and evolution on HR diagram
- Components of solar system and its evolution
- Current research in detection of exoplanets
- Basic structure of different galaxies and rotation of the Milky Way galaxy
- Distribution of chemical compounds in the interstellar medium and astrophysical conditions necessary for the emergence and existence of life
- Internet based astronomy and the collaborative citizen astronomy projects
- India’s contribution to astronomy, both in ancient times and in modern era.

SYLLABUS OF GE – 14 (Lecture-45 hours)

THEORY COMPONENT

Unit 1:
Introduction to Astronomy and Astronomical Scales: History of astronomy, wonders of the Universe, overview of the night sky, diurnal and yearly motions of the Sun, size, mass, density and temperature of astronomical objects, basic concepts of positional astronomy: Celestial sphere, Astronomical coordinate systems, Horizon system and Equatorial system

Unit 2:
Basic Parameters of Stars: Stellar energy sources, determination of distance by parallax method, aberration, proper motion, brightness, radiant flux and luminosity, apparent and absolute magnitude scales, distance modulus, determination of stellar temperature and radius, basic results of Saha ionization formula and its applications for stellar astrophysics, stellar spectra, dependence of spectral types on temperature, luminosity classification, stellar evolutionary track on Hertzsprung-Russell diagram

Unit 3:
Astronomical Instruments: Observing through the atmosphere (Scintillation, Seeing, Atmospheric Windows and Extinction). Basic Optical Definitions for Telescopes: Magnification, Light Gathering Power, Limiting magnitude, Resolving Power, Diffraction Limit. Optical telescopes, radio telescopes, Hubble space telescope, James Web space telescope, Fermi Gamma ray space telescope.
Astronomy in the Internet Age: Overview of Aladin Sky Atlas, Astrometrica, Sloan Digital Sky Survey, Stellarium, virtual telescope
Citizen Science Initiatives: Galaxy Zoo, SETI@Home, RAD@Home India

Unit 4:
Sun and the solar system: Solar parameters, Sun's internal structure, solar photosphere, solar atmosphere, chromosphere, corona, solar activity, origin of the solar system, the nebular model, tidal forces and planetary rings
Exoplanets: Detection methods

Unit 5:
Physics of Galaxies: Basic structure and properties of different types of Galaxies, Nature of rotation of the Milky Way (Differential rotation of the Galaxy), Idea of dark matter
Cosmology and Astrobiology: Standard Candles (Cepheids and SNe Type1a), Cosmic distance ladder, Olber's paradox, Hubble's expansion, History of the Universe, Chemistry of life, Origin of life, Chances of life in the solar system

Unit 6:

Astronomy in India: Astronomy in ancient, medieval and early telescopic era of India, current Indian observatories (Hanle-Indian Astronomical Observatory, Devasthal Observatory, Vainu Bappu Observatory, Mount Abu Infrared Observatory, Gauribidanur Radio Observatory, Giant Metre-wave Radio Telescope, Udaipur Solar Observatory, LIGO-India) (qualitative discussion), Indian astronomy missions (Astrosat, Aditya)

References:

Essential Readings:

1) Seven Wonders of the Cosmos, Jayant V Narlikar, Cambridge University Press
2) Fundamental of Astronomy, H. Karttunen et al. Springer
3) Modern Astrophysics, B. W. Carroll and D. A. Ostlie, Addison-Wesley Publishing Co.
4) Introductory Astronomy and Astrophysics, M. Zeilik and S. A. Gregory, Saunders College Publishing.
5) The Molecular Universe, A. G. G. M. Tielens (Sections I, II and III), Reviews of Modern Physics, Volume 85, July-September, 2013
6) Astronomy in India: A Historical Perspective, Thanu Padmanabhan, Springer

Useful websites for astronomy education and citizen science research platform

1) https://aladin.u-strasbg.fr/
2) http://www.astrometrica.at/
3) https://www.sdss.org/
4) http://stellarium.org/
5) https://www.zooniverse.org/projects/zookeeper/galaxy-zoo/
6) https://setiathome.berkeley.edu/
7) https://www.radathomeindia.org/

Additional Readings:

1) Explorations: Introduction to Astronomy, Thomos Arny and Stephen Schneider, McGraw

Hill
2) Astrophysics Stars and Galaxies K. D. Abhyankar, Universities Press
3) Textbook of Astronomy and Astrophysics with elements of cosmology, V. B. Bhatia, Narosa Publication.
4) Baidyanath Basu, An introduction to Astrophysics, Prentice Hall of India Private Limited.
5) The Physical Universe: An Introduction to Astronomy, F. H. Shu, University Science Books

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DEPARTMENT OF CHEMISTRY
Category-I

B.Sc. (H) Chemistry

DISCIPLINE SPECIFIC CORE COURSE -4 (DSC-4): CHEMISTRY OF S- AND P-BLOCK ELEMENTS

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Chemistry of s- and p-Block Elements (DSC-4: Inorganic Chemistry -II)	04	03	0	01	Class 12th Pass	----

Learning objectives

The objectives of this course are as follows:

- To develop the general principles of metallurgy and s-, p-block elements.
- To introduce the terms minerals, ores, concentration, benefaction, calcination, roasting, refining, etc. and explain the principles of oxidation and reduction as applied to the extraction procedures.
- To make students ware of different methods of purification of metals, such as electrolytic, oxidative refining, VanArkel-De Boer process and Mond's process are discussed and applications of thermodynamic concepts like that of Gibbs energy and entropy to the extraction of metals.
- To familiarize students with the patterns and trends exhibited by s- and p-block elements and their compounds with emphasis on synthesis, structure, bonding and uses.
- To impart information about the fundamentals of internal and external redox indicators, and iodometric/iodimetric titrations.

Learning outcomes

By studying this course, students will be able to:

- Learn the fundamental principles of metallurgy and understand the importance of recovery of by-products during extraction.
- Applications of thermodynamic concepts like that of Gibbs energy and

entropy to the principles of extraction of metals.

- Learn about the characteristics of s- and p- block elements as well as the synthesis, structure, bonding and uses of their compounds
- Understand the concept and use of internal and external redox indicators
- Comprehend the theory and application of iodometric and iodimetric titrimetric analysis

SYLLABUS OF DSC-4

UNIT – I: General Principles of Metallurgy **(6 Hours)**

Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon and carbon monoxide as reducing agent. Electrolytic Reduction, Hydrometallurgy with reference to cyanide process for silver and gold. Methods of purification of metals: Electrolytic process, Van Arkel-De Boer process, Zone refining. Brief discussion of metals and alloys used in ancient and medieval India.

UNIT – II: **Chemistry of s- Block Elements** **(15 Hours)**

General characteristics: melting point, flame colouration, reducing nature, diagonal relationships and anomalous behavior of first member of each group. Reactions of alkali and alkaline earth metals with oxygen, hydrogen, nitrogen and water.

Common features such as ease of formation, thermal stability, energetics of dissolution, and solubility of the following alkali and alkaline earth metal compounds: hydrides, oxides, peroxides, superoxides, carbonates, nitrates, sulphates.

Complex formation tendency of s-block elements; structure of the following complexes: crown ethers and cryptates of Group I; basic beryllium acetate, beryllium nitrate, EDTA complexes of calcium and magnesium.

Solutions of alkali metals in liquid ammonia and their properties

UNIT – III: Chemistry of *p*-Block Elements **(9 Hours)**

Electronic configuration, atomic and ionic size, metallic/non-metallic character, melting point, ionization enthalpy, electron gain enthalpy, electronegativity, Catenation, Allotropy of C, P, S; inert pair effect, diagonal relationship between B and Si and anomalous behaviour of first member of each group.

UNIT – IV: Compounds of *p*-Block Elements **(15 Hours)**

Acidic/basic nature, stability, ionic/covalent nature, oxidation/reduction, hydrolysis, action of heat on the following:

- Hydrides of Group 13 (only diborane), Group 14, Group 15 (EH3 where E = N, P,As, Sb, Bi), Group 16 and Group 17.
- Oxoacids of phosphorus, sulphur and chlorine
- Interhalogen and pseudohalogen compound
- Clathrate compounds of noble gases, xenon fluorides (MO treatment of XeF_2).

Practical component – 30 Hours

1. **Redox Titrations**
   (i) Estimation of Fe(II) with $K_2Cr_2O_7$ using diphenylamine as internal indicator.
   (ii) Estimation of Fe(II) with $K_2Cr_2O_7$ using N-phenyl anthranilic acid as internal indicator.
   (iii) Estimation of Fe(II) with $K_2Cr_2O_7$ using external indicator.

2. **Iodo/Iodimetric Titrations**
   (i) Estimation of Cu(II) using sodium thiosulphate solution (Iodometrically).
   (ii) Estimation of $K_2Cr_2O_7$ using sodium thiosulphate solution (Iodometrically).
   (iii) Estimation of antimony in tartaremetic iodimetrically.
   (iv) Estimation of Iodine content in iodized salt.

Essential/recommended readings

Theory:

1. Lee, J. D.; (2010), **Concise Inorganic Chemistry**, Wiley India.
2. Huheey, J. E.; Keiter, E. A.; Keiter; R.L.; Medhi, O.K. (2009), **Inorganic Chemistry-Principles of Structure and Reactivity**, Pearson Education.
3. Atkins, P. W.; Overton, T. L.; Rourke, J. P.; Weller, M. T.; Armstrong, F. A. (2010), **Shriver and Atkins Inorganic Chemistry**, 5th Edition, Oxford University Press.
4. Miessler, G. L.; Fischer P. J.; Tarr, D. A. (2014), **Inorganic Chemistry**, 5th Edition, Pearson.
5. Housecraft, C. E.; Sharpe, A. G., (2018), **Inorganic Chemistry**, 5thEdition, Pearson.
6. Canham, G. R., Overton, T. (2014), **Descriptive Inorganic Chemistry,** 6th Edition, Freeman and Company.
7. Greenwood, N. N.; Earnsaw, A., (1997), **Chemistry of Elements**, 2nd Edition, Elsevier.

Practicals:

1. Jeffery, G. H.; Bassett, J.; Mendham, J.; Denney, R. C. (1989), Vogel's Text book of **Quantitative Chemical Analysis**, John Wiley and Sons.
2. Harris, D. C.; Lucy, C. A. (2016), **Quantitative Chemical Analysis**, 9th Edition, Freeman and Company.
3. Day, R. A.; Underwood, A. L. (2012), **Quantitative Analysis**, 6th Edition, PHI Learning Private Limited.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 5 (DSC-5): HALOALKANES, ARENES, HALOARENES, ALCOHOLS, PHENOLS, ETHERS AND EPOXIDES

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Haloalkanes, Arenes, Haloarenes, Alcohols, Phenols, Ethers and Epoxides (DSC-5: Organic Chemistry-II)	04	02	0	02	Class 12th Pass	---

Learning Objectives

The Learning Objectives of this course are as follows:

- To impart understanding of the chemistry of organic functional groups, which include haloalkanes, aromatic hydrocarbons, haloarenes and some oxygen containing functional groups, along with their reactivity patterns.
- To develop understanding of detailed reactions and mechanistic pathways for each functional group to unravel the spectrum of organic chemistry and the extent of organic transformations.
- To aid in the paramount learning of the concepts and their applications.

Learning outcomes

On completion of the course, the student will be able to:

- Understand reactions of arenes, haloarenes and some oxygen containing functional groups.
- Understand the concept of protection and deprotection
- Use the synthetic chemistry learnt in this course to do functional group transformations.
- Propose plausible mechanisms for the reactions under study.

SYLLABUS OF DSC-5

Unit - 1: Haloalkanes **(10 Hours)**

Alkyl halides: Methods of preparation and properties, nucleophilic substitution reactions – S_N1, S_N2 and S_Ni mechanisms with stereochemical aspects and effect of solvent; nucleophilic substitution v/s elimination.

Organometallic compounds of Mg (Grignard reagent) – Use in synthesis of organic compounds.

Unit - II: Aromatic Hydrocarbons **(06 Hours)**

Concept of Aromaticity and anti-aromaticity; Electrophilic aromatic substitution: halogenation, nitration, sulphonation, Friedel Crafts alkylation/acylation with their mechanism. Directing effects of groups in electrophilic substitution.

Unit - III: Aryl halides **(04 Hours)**

Preparation (including preparation from diazonium salts) and properties, nucleophilic aromatic substitution; S_NAr, Benzyne mechanism. Relative reactivity of alkyl, allyl, benzyl, vinyl and aryl halides towards nucleophilic substitution reactions.

Unit - IV: Alcohols, Phenols, Ethers & Epoxides **(10 Hours)**

Alcohols: Relative reactivity of 1°, 2°, 3° alcohols, reactions of alcohols with sodium, HX (Lucas test), esterification, oxidation (with PCC, alkaline $KMnO_4$, acidic dichromate, conc. HNO_3). Oppenauer oxidation; Diols: oxidation of diols by periodic acid and lead tetraacetate, Pinacol-Pinacolone rearrangement.

Phenols: Preparation using Cumene hydroperoxide, Acidity and factors affecting it, Kolbe's–Schmidt reactions, Riemer-Tiemann reaction, Houben–Hoesch condensation, Schotten–Baumann reaction, Fries and Claisen rearrangements and their mechanism. Ethers and Epoxides: Acid and Base catalyzed cleavage reactions.

Practical - 60 Hours

1. Acetylation of any one of the following compounds: amines (aniline, *o*-, *m*-, *p*-toluidines and *o*-, *m*-, *p*-anisidine) and phenols (*β*-naphthol, salicylic acid) by any one method:
   i. Using conventional method ii. Using green approach
2. Benzolyation of one of the following amines (aniline, *o*-, *m*-, *p*-toluidines and *o*, *m*-, *p*-anisidine) or one of the following phenols (*β*-naphthol, resorcinol, *p*-cresol) by Schotten-Baumann reaction.
3. Bromination of acetanilide/aniline/phenol by anyone of the following:
   (a) Green method b) Conventional method
4. Nitration of nitrobenzene/chlorobenzene.
5. Haloform reaction of ethanol.
6. Oxidation of benzyl alcohol to benzoic acid
7. Estimation of the given sample of phenol/amine by:

a) Acetylation b) Bromate-Bromide method

8. Functional group tests for alcohols, phenols, carboxylic acids, phenols, carbonyl compounds, esters.

Essential/recommended readings

Theory:

1. Morrison, R. N., Boyd, R. N., Bhattacharjee, S.K. (2010), **Organic Chemistry**, 7th Edition, Dorling Kindersley (India) Pvt. Ltd., Pearson Education.
2. Finar, I.L. (2002), **Organic Chemistry**, Volume 1, 6th Edition, Dorling Kindersley (India) Pvt. Ltd., Pearson Education.
3. Ahluwalia, V.K.; Bhagat, P.; Aggarwal, R.; Chandra, R. (2005), **Intermediate for Organic Synthesis,** I.K. International.
4. Solomons, T.W.G., Fryhle, C.B., Snyder, S.A. (2017), **Organic Chemistry**, 12th Edition, Wiley.

Practical:

1. Mann, F.G., Saunders, B.C. (2009), **Practical Organic Chemistry**, 4th Edition, Pearson Education.
2. Furniss, B.S., Hannaford, A.J., Smith, P.W.G., Tatchell, A.R. (2005), **Vogel's Textbook of Practical Organic Chemistry**, Pearson.
3. Ahluwalia, V.K., Aggarwal, R. (2004), **Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis**, University Press.
4. Ahluwalia, V.K., Dhingra, S. (2004), **Comprehensive Practical Organic Chemistry: Qualitative Analysis**, University Press.
5. Pasricha, S., Chaudhary, A. (2021), **Practical Organic Chemistry: Volume–I**, I K International Publishing house Pvt. Ltd, New Delhi
6. Pasricha, S., Chaudhary, A. (2021), **Practical Organic Chemistry: Volume–II**, I K International Publishing house Pvt. Ltd, New Delhi

Suggestive readings

1. Carey, F.A., Sundberg, R. J. (2008), **Advanced Organic Chemistry: Part B: Reaction and Synthesis**, Springer.
2. Bruice, P.Y. (2020), **Organic Chemistry**, 3rd Edition, Pearson.
3. Patrick, G. (2012), **BIOS Instant Notes in Organic Chemistry**, Viva Books.
4. Parashar, R.K., Ahluwalia, V.K. (2018), **Organic Reaction Mechanism,** 4th Edition, Narosa Publishing House.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 6 (DSC-6): Thermodynamics and its Applications

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Chemical Thermodynamics and its Applications (DSC – 6: Physical Chemistry – II)	04	03	-	01	Class XII Pass	----

Learning Objectives

The Learning Objectives of this course are as follows:

- To make students understand thermodynamic concepts, terminology, properties of thermodynamic systems, laws of thermodynamics and their correlation with other branches of physical chemistry and make them able to apply thermodynamic concepts to the system of variable compositions, equilibrium and colligative properties.

Learning outcomes

On completion of the course, the student will be able to:

- Understand the three laws of thermodynamics, concept of State and Path functions, extensive and intensive properties.
- Derive the expressions of ΔU, ΔH, ΔS, ΔG, ΔA for an ideal gas under different conditions.
- Explain the concept of partial molar properties.

SYLLABUS OF DSC-6

UNIT – I: Basic Concepts of Chemical Thermodynamics (06 Hours)

Intensive and extensive variables; state and path functions; isolated, closed and open systems.

Mathematical treatment - Exact and inexact differential, Partial derivatives, Euler's reciprocity rule, cyclic rule.

UNIT – II: First law and Thermochemistry (15 Hours)

Concept of heat, Q, work, W, internal energy, U, and statement of first law; enthalpy, H, relation between heat capacities, Joule Thompson Porous Plug experiment, Nature of Joule Thompson coefficient, calculations of Q, W, ΔU and ΔH for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions.

Enthalpy of reactions: standard states; enthalpy of neutralization, enthalpy of hydration, enthalpy of formation and enthalpy of combustion and its applications, bond dissociation energy and bond enthalpy; effect of temperature (Kirchhoff's equations) on enthalpy of reactions.

UNIT – III: Second Law (15 Hours)

Concept of entropy; statement of the second law of thermodynamics, Carnot cycle. Calculation of entropy change for reversible and irreversible processes (for ideal gases). Free Energy Functions: Gibbs and Helmholtz energy; variation of S, G, A with T, V, P; Free energy change and spontaneity (for ideal gases). Relation between Joule-Thomson coefficient and other thermodynamic parameters; inversion temperature; Gibbs-Helmholtz equation; Maxwell relations; thermodynamic equation of state.

UNIT – IV Third Law (03 Hours)

Statement of third law, unattainability of absolute zero, calculation of absolute entropy of molecules, concept of residual entropy, calculation of absolute entropy of solid, liquid and gases.

UNIT – V Systems of Variable Composition (06 Hours)

Partial molar quantities, dependence of thermodynamic parameters on composition; Gibbs Duhem equation, chemical potential of ideal mixtures, Change in thermodynamic functions on mixing of ideal gases.

Practical – 30 Hours

Thermochemistry:

(a) Determination of heat capacity of a calorimeter for different volumes using change of enthalpy data of a known system (method of back calculation of heat capacity of calorimeter from known enthalpy of solution of sulphuric acid or enthalpy of neutralization).
(b) Determination of heat capacity of a calorimeter for different volumes using heat gained equal to heat lost by cold water and hot water.
(c) Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.

(d) Determination of the enthalpy of ionization of ethanoic acid.
(e) Determination of integral enthalpy solution of endothermic salts.
(f) Determination of integral enthalpy solution of exothermic salts.
(g) Determination of basicity of a diprotic acid by the thermochemical method in terms of the changes of temperatures observed in the graph of temperature versus time for different additions of a base. Also calculate the enthalpy of neutralization of the first step.
(h) Determination of enthalpy of hydration of salt.
(i) Study of the solubility of benzoic acid in water and determination of ΔH.

Any other experiment carried out in the class.

Essential/recommended readings
Theory

1. Peter, A.; Paula, J. de. (2011), **Physical Chemistry**, 9th Edition, Oxford University Press.
2. Castellan, G. W. (2004), **Physical Chemistry**, 4th Edition, Narosa.
3. Kapoor, K.L. (2015), **A Textbook of Physical Chemistry**, Vol 2, 6th Edition, McGraw Hill Education.
4. Kapoor, K.L., **A Textbook of Physical Chemistry**, Vol 3, 5th Edition, McGraw Hill Education.
5. McQuarrie, D. A.; Simon, J. D. (2004), **Molecular Thermodynamics**, Viva Books Pvt. Ltd.

Practical:

1. Khosla, B.D.; Garg, V.C.; Gulati, A. (2015), **Senior Practical Physical Chemistry**, R. Chand & Co, New Delhi.
2. Kapoor, K.L. (2019), **A Textbook of Physical Chemistry**, Vol.7, 1st Edition, McGraw Hill Education.
3. Garland, C. W.; Nibler, J. W.; Shoemaker, D. P. (2003), **Experiments in Physical Chemistry**, 8th Edition, McGraw-Hill, New York.

Suggestive readings

1. Levine, I.N. (2010), **Physical Chemistry**, Tata Mc Graw Hill.
2. Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A.; Will, S. (2011), **Commonly asked Questions in Thermodynamic**s. CRC Press.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

Category II

BSc. Life Science with Chemistry as one of the Core Discipline

DISCIPLINE SPECIFIC CORE COURSE – 4:

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Chemical Bonding and Elements in Biological System CHEM-DSC-02	4	2	0	2	Class XII Pass	----

Learning Objectives

The Learning Objectives of this course are as follows:

- Students gain basic knowledge of chemical bonding in compounds which is a necessary pre-requisite in understanding the general properties of the compound.
- Unit 2 reviews the importance of inorganic chemical species, especially metals in biological systems, their classification and detailed discussion of toxic metals.
- The discussions also provide them the details of sodium-potassium pump, role of some metal ions such as calcium, magnesium and the role of iron in transport and storage system

Learning outcomes

By the end of the course, the students will be able to:

- Understand the concept of lattice energy using Born-Landé and Born Haber Cycle and their applications
- Rationalize the conductivity of metals, semiconductors and insulators based on the Band theory.
- Understand the importance and application of chemical bonds, inter-molecular and intramolecular weak chemical forces and their effect on melting points, boiling points, solubility and energetics of dissolution.
- Know about the essential, non-essential, trace and toxic metal ions and their role in biological system and effects of their deficiency. They will also learn their dose response relationship curves.
- Understand active and Passive transport and diagrammatically explain the working of

the sodium-potassium pump in organisms and the factors affecting it

- Explain the sources and consequences of excess and deficiency of trace metals and learn about the toxicity of certain metal ions, the reasons for toxicity
- Storage and transport of iron in bio-systems

SYLLABUS OF DSC-4

Unit I: Chemical Bonding (18 Hours)

Ionic Bonding: General characteristics of ionic bonding, Lattice Enthalpy and Solvation Enthalpy and their relation to stability and solubility of ionic compounds, Born-Lande equation for calculation of Lattice Enthalpy (no derivation), Born-Haber cycle and its applications, polarizing power and polarizability, Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.

Covalent Bonding: Valence Bond Approach, Hybridization and VSEPR Theory with suitable examples, Concept of resonance and resonating structures in various inorganic and organic compounds, Molecular Orbital Approach: Rules for the LCAO method, bonding, nonbonding and antibonding MOs and their characteristics for s-s, s-p and p-p combinations of atomic orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of s-p mixing) and heteronuclear diatomic molecules such as CO, NO and NO^+.

Brief introduction to Metallic Bonding, Hydrogen Bonding, van der Waals forces

Unit II: Elements in Biological System (12 Hours)

Classification of elements in biological system, Geochemical effect on the distribution of metals, Metal ions present in biological systems with special reference to Na^+, K^+, Ca^{2+}, Mg^{2+}, Fe^{2+}, Cu^{2+} and Zn^{2+}, Sodium / K-pump, Role of Ca^{2+} (blood clotting and structural), Role of Mg^{2+} in chlorophyll and energy production, Excess and deficiency of some trace metals, Toxicity of metal ions (Hg, Pb, Cd and As), reasons for toxicity, Dose response relationship curves of metal ions, Iron and its application in bio-systems, Storage and transport of iron.

PRACTICALS: 60 Hours

1. Preparation of standard solutions.
2. Estimation of Sodium carbonate using HCl by acid base titration.
3. Estimation of carbonate and hydroxide present together in a mixture.
4. Estimation of carbonate and bicarbonate present together in a mixture.
5. Estimation of free alkali present in different soaps/detergents
6. Estimation of oxalic acid using $KMnO_4$ by redox titration.
7. Estimation of Mohr's salt using $KMnO_4$ by redox titration.
8. Determination of dissolved oxygen in water.
9. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal and external indicators.
10. Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$
11. Paper Chromatographic separation of mixture of metal ions

a. Cu^{2+}, Cd^{2+}
b. Ni^{2+}, Co^{2+}.

12. Any suitable experiment (other than the listed ones) based upon neutralisation/redox reactions.

References:

Theory:

1. Lee, J.D.; (2010), **Concise Inorganic Chemistry**, Wiley India.
2. Huheey, J.E.; Keiter, E.A.; Keiter; R. L.; Medhi, O.K. (2009), **Inorganic Chemistry-Principles of Structure and Reactivity**, Pearson Education.
3. Douglas, B.E.; McDaniel, D.H.; Alexander, J.J. (1994), **Concepts and Models of Inorganic Chemistry**, John Wiley & Sons.
4. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A. (2010), Shriver and Atkins **Inorganic Chemistry**, 5th Edition, Oxford University Press.
5. Crichton, R.; (2019), **Biological inorganic chemistry**: **a new introduction to molecular structure and function**, third edition, Elsevier, Academic Press.
6. Kaim, W; Schwederski, B.; Klein, A. (2013), **Bioinorganic Chemistry - Inorganic Elements in the Chemistry of Life: An Introduction and Guide**, 2nd Edition, Wiley.

Practical:

1. Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C. (1989), **Vogel's Textbook of Quantitative Chemical Analysis**, John Wiley and Sons.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

<u>**Category II**</u>

BSc. Physical Science with Chemistry as one of the Core Disciplines

DISCIPLINE SPECIFIC CORE COURSE – 4:

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Periodic Properties and Chemical Bonding DSC-4 Chemistry-II	4	2	0	2	Class 12th Pass	----

Learning Objectives

The Learning Objectives of this course are as follows:

- The course discusses the periodicity in properties with reference to the s, p and d block, which is necessary in understanding their group chemistry.
- It provides basic knowledge about ionic, covalent and metallic bonding underlining the fact that chemical bonding is best regarded as a continuum between the three cases.
- It provides an overview of hydrogen bonding and van derWaal's forces which influence the melting points, boiling points, solubility and energetics of dissolution of compounds

Learning outcomes

By the end of the course, the students will be able to:

- Understand periodicity in ionization enthalpy, electron gain enthalpy, electronegativity and enthalpy of atomization.
- Understand variability in oxidation state, colour, metallic character, magnetic and catalytic properties and ability to form complexes
- Understand the concept of lattice energy using Born-Landé expression.
- Draw Born Haber Cycle and analyse reaction energies.
- Draw the plausible structures and geometries of molecules using VSEPR theory.
- Understand and draw MO diagrams (homo- & hetero-nuclear diatomic molecules). Understand the importance and applications of hydrogen and van der Wall bonding

SYLLABUS OF DSC-4

Unit I: Periodic Properties (12 Hours)

Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy, inert pair effect.

General group trends of s, p and d block elements with special reference to Ionization Enthalpy, Electron Gain Enthalpy, Electronegativity, Enthalpy of Atomization, oxidation state, colour, metallic character, magnetic and catalytic properties, ability to form complexes

UNIT II: Chemical Bonding (18 Hours)

Ionic Bonding: General characteristics of ionic bonding, Lattice Enthalpy and Solvation Enthalpy and their relation to stability and solubility of ionic compounds, Born-Lande equation for calculation of Lattice Enthalpy (no derivation), Born-Haber cycle and its applications, polarizing power and polarizability, Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.

Covalent Bonding: Valence Bond Approach, Hybridization and VSEPR Theory with suitable examples, Concept of resonance and resonating structures in various inorganic and organic compounds, Molecular Orbital Approach: Rules for the LCAO method, bonding, nonbonding and antibonding MOs and their characteristics for s-s, s-p and p-p combinations of atomic orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of s-p mixing) and heteronuclear diatomic molecules such as CO, NO and NO^+.

Brief introduction to Metallic Bonding, Hydrogen Bonding, van der Waal's Forces

PRACTICALS: 60 Hours

1. Preparation of standard solutions.
2. Estimation of Sodium carbonate with HCl
3. Estimation of oxalic acid by titrating it with $KMnO_4$.
4. Estimation of Mohr's salt by titrating it with $KMnO_4$.
5. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.
6. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal and external indicators.
7. Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$.
8. Chromatographic separation of mixture of metal ions Cu^{2+}, Cd^{2+} or Ni^{2+}, Co^{2+}.
9. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using
   a). internal indicator
   b). external indicator
10. Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$.
11. Paper Chromatographic separation of mixture of metal ions
    a). Cu^{2+} , Cd^{2+}
    b). Ni^{2+} , Co^{2+}
12. Any suitable experiment (other than the listed ones) based upon neutralisation/redox reactions.

References:

Theory:

1. Huheey, J.E.; Keiter, E.A., Keiter; R. L.; Medhi, O.K. (2009), **Inorganic Chemistry-Principles of Structure and Reactivity**, Pearson Education
2. Shriver, D.D.; Atkins, P.; Langford, C.H. (1994), **Inorganic Chemistry** 2nd Ed., Oxford University Press.
3. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A. (2010), **Inorganic Chemistry**, 5th Edition, W. H. Freeman and Company.
4. Lee, J.D.; (2010), **Concise Inorganic Chemistry**, Wiley India
5. Douglas, B.E.; McDaniel, D.H.; Alexander, J.J. (1994),**Concepts and Models of Inorganic Chemistry**, John Wiley & Sons.
6. Wulfsberg, G (2002), **Inorganic Chemistry**, Viva Books Private Limited.
7. Miessler, G.L.; Fischer P.J.; Tarr, D. A. (2014), **Inorganic Chemistry**, 5th Edition, Pearson.

Practical:

- Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C. (1989), **Vogel's Textbook of Quantitative Chemical Analysis**, John Wiley and Sons.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

Category-I

B.Sc. (H) Analytical Chemistry

DISCIPLINE SPECIFIC CORE COURSE – 4: DSC-4:AC-2

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Course Title: SEPARATION METHODS-I **Course Code:** Analytical Chemistry-2 (DSC4:AC-2)	04	02	00	02	Class XII Pass	---

Learning Objectives

The Learning Objectives of this course are as follows:

- To acquire basic knowledge of the analytical chemistry of important techniques that will provide the basis for their industrial production methods.
- To provide an adequate mastery of analytical methods used for the determination of commercial/domestic raw materials and finished product quality.

Learning outcomes

By the end of this course, students will be able to:

- Become familiar with fundamental concepts of partition coefficients and their role in achieving separations across different types of chromatography.
- Develop the core skills to parse existing chromatographic protocols and identify the key factors influencing a chromatography experiment.
- Understand the underlying assumptions of the most common chromatographic separation techniques and approaches to method validation.
- Understand the concept of solubility and their application in separation using distribution law.

SYLLABUS OF Analytical Chemistry-2 (DSC-4: AC-2)

Theory Component

UNIT – I: Chromatography (08 Hours)

Classification of chromatographic methods: Principles of differential migration, description of chromatographic process, distribution coefficients, modes of chromatography. the chromatography (elution time and volume) capacity factor, column efficiency and resolution, sample preparation.

UNIT – II: Techniques of paper chromatography (06 Hours)

Experimental modifications, various modes of developments, nature of paper, detections of spots, retardation factors, factors that affect reproducibility of R_f values (due to paper, solvent system, sample, development procedures), selection of solvent, quantitative analysis, applications.

UNIT – III: Thin Layer Chromatography (06 Hours)

Stationary phase, adsorbents, liquid phase support, plate preparation, mobile phase, sample application, development, saturation of chamber, detection of spot, R_f values (effect of adsorbent, solvent, solute, development process), quantitative analysis, applications.

UNIT – IV: Solvent Extraction (04 Hours)

Distribution law, determination of distribution ratio, batch extraction, continuous extraction, discontinuous extraction, counter-current extraction.

UNIT –V: Dialysis and membrane filtration (06 Hours)

General laboratory methods, filters-nitrocellulose, fiberglass and polycarbonates.

Practical component – 60 Hours

1. Separation and identification of amino acids present in the given mixture by **radial** and **ascending** paper Chromatography (*Perform both*).
2. Separation of ortho-nitrophenol & para-nitrophenol and *o*- and *p*-amino phenol by thin layer chromatography (TLC) and calculation of their R_f values.
3. Separation of constituents of leaf pigments by thin layer chromatography and paper chromatography (*radial & ascending both*).
4. Separation of a mixture of compounds by solvent extraction.
5. Separation of a mixture of naphthalene, benzoic acid and 2-naphthol.
6. Separation of a mixture of 1,4-dimethoxybenzene, 2-chloro benzoic acid and *p*-cresol.
7. Analysis of soil samples (*at least three soil samples to be collected for analysis*) collected from college nursery, sports ground Delhi villages/ Yamuna River bank.

   (**a**) Determination of pH of soil samples.
   (**b**) Determination of total soluble salts.
   (**c**) Determination of carbonate and bicarbonate.
   (**d**) Determination of calcium, magnesium and iron.

(e) Determination of conductance of the soil samples.

8. Industrial visit to STP plant.

Essential/recommended readings

- Fifield,F.W.; Kealey, D. (2000), Principles and Practice of Analytical Chemistry, Wiley.
- Harris, D. C. (2007), Exploring Chemical Analysis, W.H. Freeman and Co.
- Harris, D. C. (2007), Quantitative Chemical Analysis, 6th Edition, Freeman
- Mikes, O. (2000), Laboratory Handbook of Chromatographic methods, D.Van Nostrand Company Inc.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 5: DSC5:C2

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
PERIODIC PROPERTIES AND CHEMICAL BONDING CHEMISTRY-2 (DSC5-C2)	04	02	0	02	Class XII Pass	----

Learning Objectives

The Learning Objectives of this course are as follows:

- The course discusses the periodicity in properties with reference to the s, p and d block, which is necessary in understanding their group chemistry.
- It provides basic knowledge about ionic, covalent and metallic bonding underlining the fact that chemical bonding is best regarded as a continuum between the three cases.
- It provides an overview of hydrogen bonding and van der Waal forces which influence the melting points, boiling points, solubility and energetics of dissolution of compounds.

Learning outcomes

By the end of this course, students will be able to:

- Understand periodicity in ionization enthalpy, electron gain enthalpy, electronegativity and enthalpy of atomization.
- Understand variability in oxidation state, colour, metallic character, magnetic and catalytic properties and ability to form complexes
- Understand the concept of lattice energy using Born-Landé expression.
- Draw Born Haber Cycle and analyse reaction energies.
- Draw the plausible structures and geometries of molecules using VSEPR theory.
- Understand and draw MO diagrams (homo- & hetero-nuclear diatomic molecules).
- Understand the importance and applications of hydrogen and van der Wall bonding.

SYLLABUS OF Chemistry-2 (DSC-5:C2)

UNIT – I: Periodic Properties (12 Hours)

Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy, inert pair effect.

General group trends of s, p and d block elements with special reference to Ionization Enthalpy, Electron Gain Enthalpy, Electronegativity, Enthalpy of Atomization, oxidation state, colour, metallic character, magnetic and catalytic properties, ability to form complexes.

UNIT – II: Bonding in Coordination Compounds (18 Hours)

Ionic Bonding: General characteristics of ionic bonding, Lattice Enthalpy and Solvation Enthalpy and their relation to stability and solubility of ionic compounds, Born-Lande equation for calculation of Lattice Enthalpy (no derivation), Born-Haber cycle and its applications, polarizing power and polarizability, Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.

Covalent Bonding: Valence Bond Approach, Hybridization and VSEPR Theory with suitable examples, Concept of resonance and resonating structures in various inorganic and organic compounds, Molecular Orbital Approach: Rules for the LCAO method, bonding, nonbonding and antibonding MOs and their characteristics for s-s, s-p and p-p combinations of atomic orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of s-p mixing) and heteronuclear diatomic molecules such as CO, NO and NO^+.
Metallic Bonding, Hydrogen Bonding, van der Waals Forces.

Practical – 60 Hours

1. Preparation of standard solutions of different normality and molarity of Mohr's salt and oxalic acid.
2. Estimation of free alkali present in different soaps and detergents (*At least two samples to be taken*).
3. Estimation of oxalic acid by titrating it with $KMnO_4$ (*Provide at least two unknown solutions*).
4. Estimation of Mohr's salt by titrating it with $KMnO_4$ (*Provide a tleast two unknown solutions*).
5. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.
6. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal and external indicators.
7. Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$.
8. Chromatographic separation of mixture of metal ions Cu^{2+}, Cd^{2+} and Ni^{2+}, Co^{2+}.

Essential/recommended readings

1. Huheey, J.E.; Keiter, E.A., Keiter; R. L.; Medhi, O.K. (2009), Inorganic Chemistry-Principles of Structure and Reactivity, Pearson Education
2. Shriver, D.D.; Atkins, P.; Langford, C.H. (1994), Inorganic Chemistry 2nd Ed., Oxford University Press.
3. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A. (2010), Inorganic Chemistry, 5th Edition, W. H. Freeman and Company.

4. Lee, J.D.; (2010), Concise Inorganic Chemistry, Wiley India
5. Douglas, B.E.; McDaniel, D.H.; Alexander, J.J. (1994), Concepts and Models of Inorganic Chemistry, John Wiley & Sons.
6. Wulfsberg, G (2002), Inorganic Chemistry, Viva Books Private Limited.
7. Miessler, G.L.; Fischer P.J.; Tarr, D. A. (2014), Inorganic Chemistry, 5th Edition, Pearson.
8. Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C. (1989), Vogel's Textbook of Quantitative Chemical Analysis, John Wiley and Sons.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 6: Mathematics-1:DSC6

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Topics in Calculus Mathematics-1 (DSC6)	04	**03**	**01**	**0**	**Class 12th Pass**	----

Course Objectives

The Learning Objectives of this course are as follows:

- The primary objective of this course is to introduce the basic tools of calculus which are helpful in understanding their applications in many real-world problems.
- Students will be able to understand/create various mathematical models in everyday life.

Course Learning Outcomes: This course will enable the students to:

- Understand continuity and differentiability in terms of limits and graphs of certain functions.
- Describe asymptotic behaviour in terms of limits involving infinity.
- Use of derivatives to explore the behaviour of a given function locating and classify its extrema and graphing the function.
- Apply the concepts of asymptotes, and inflexion points in tracing of Cartesian curves.
- Compute the reduction formulae of standard transcendental functions with applications.

Syllabus: Theory Component

Unit 1: Limits, Continuity and Differentiability – 20 Hours

Limit of a function, $\varepsilon-\delta$ definition of a limit, Infinite limits, Continuity and types of discontinuities; Differentiability of a function, Successive differentiation: Calculation of the *n*th derivatives, Leibnitz theorem; Partial differentiation, Euler's theorem on homogeneous functions.

Unit 2: Mean Value Theorems and its Applications – 20 Hours

Rolle's theorem, Mean value theorems and applications to monotonic functions and inequalities; Taylor's theorem, Taylor's series, Maclaurin's series expansions of e^x, $\sin x$, $\cos x$, $\log(1+x)$ and $(1+x)^m$; Indeterminate forms.

Unit 3: Tracing of Curves and Reduction Formulae – 20 Hours

Asymptotes (parallel to axes and oblique), Concavity and inflexion points, Singular points, Tangents at the origin and nature of singular points, Curve tracing(cartesian and polar equations). Reduction formulae for $\int \sin^n x\, dx, \int \cos^n x\, dx,$ and $\int \sin^m x \cos^n x\, dx$ and their applications.

Practical Component (if any): NIL

Essential/recommended readings

- Prasad, Gorakh (2016). *Differential Calculus* (19th ed.). Pothishala Pvt. Ltd. Allahabad.
- Prasad, Gorakh (2015). *Integral Calculus*. Pothishala Pvt. Ltd. Allahabad.

Additional Readings:

- Apostol, T. M. (2007). *Calculus*: *One-Variable Calculus with An Introduction to Linear Algebra* (2nd ed.). Vol. 1. Wiley India Pvt. Ltd.
- Ross, Kenneth. A. (2013).*Elementary Analysis*: *The Theory of Calculus* (2nd ed.).Undergraduate Texts in Mathematics, Springer. Indian reprint.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

Category I

BSc. (Hons.) Industrial Chemistry

DISCIPLINE SPECIFIC CORE COURSE – 4: (DSC-4) Fossil Fuels and Cleansing Agents

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Fossil Fuels and Cleansing Agents (DSC-4: Industrial Chemistry -II)	04	02	0	02	Class 12th Pass	----

Learning Objectives

- After studying this course, student shall be able to understand the different aspects of industrial processes of fossil fuels in detail.
- Optimised use of limited resources of non-renewable energy and technology investment in improving the production of renewable cleaner energy sources and biofuels.
- The analytical approach of this course is to enhance the reasoning and to understand the mechanical part of the industry.

Learning outcomes

By the end of the course, the students will be able to:

- Know about fuels, composition, carbonization of coal, liquefaction, and coal tar based chemicals and layout for key processes in oil refining.
- Understand the role of petroleum and petrochemical industry, composition, applications, process-cracking. Increasing demand for non-petroleum fuels, synthetic fuels.
- Understand different fossil fuel products and processes
- Know types of oils, familiarized with rancidity, saponification value, iodine number, Superiority of synthetic detergents, gain knowledge about surfactants.

SYLLABUS OF DSC-4

UNIT – I: Fuel Chemistry and Introduction to Coal (10 Hours)

Review of energy sources (renewable and non-renewable). Classification of fuels and their calorific value. Introduction of coal, uses of coal (fuel and non-fuel) in various industries (at least three examples), its types and composition, carbonization of coal. Coal gas, producer gas and water gas—composition and their uses, uses of coal-tar based chemicals, Requisites of a good metallurgical coke, Coal liquefaction and Solvent refining.

UNIT – II: Petroleum and Petrochemical Industry (12 Hours)

Composition of crude petroleum, Refining and different types of petroleum products and their applications. Fractional distillation (principle and process), Cracking (thermal and catalytic cracking), Reforming petroleum and non-petroleum fuels (LPG,CNG,LNG, bio-gas, biofuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels

UNIT – III: Oils and Fats (8 Hours)

Classification of oils, hydrogenation of oils, rancidity, saponification value, iodine number, acid value, soap and synthetic detergent, preparation of soap and detergent, different types of soap and their composition, surfactants (LAS, ABS, LABS).

Practical component- 60 Hours

Industrial Chemistry-II

1. Determination of alkali in water samples and soaps.
2. Determination of iodine value of the oils/ fats.
3. Determination of saponification value of the oils/ fats.
4. Determination of acid value of the oils/ fats.
5. To determine the moisture content of different fuels.
6. Estimation of hardness of water by titration with soap solution.
7. Preparation of soap.
8. Preparation of biodiesel from waste cooking oil and its characterization.
9. To compare the viscosity of biodiesel and vegetable oil.
10. To determine the density of the given fuel sample.
11. Characterization of different petroleum products using UV and IR.

Essential/recommended readings

Theory:

1. Vermani, O. P.; Narula, A. K. (2004), **Industrial Chemistry,**Galgotia Publications Pvt. Ltd., New Delhi.
2. Bhatia, S. C. (2004), **Chemical Process Industries**, Vol. I & II, CBS Publishers, New Delhi.
3. Jain, P. C.; Jain, M. (2013), **Engineering Chemistry**, DhanpatRai& Sons, Delhi.
4. Gopalan, R. Venkappayya, D.; Nagarajan, S. (2004), **Engineering Chemistry**, Vikas Publications.
5. Sharma, B. K. (1997), **Engineering Chemistry**, Goel Publishing House, Meerut.

Practical:

1. Verma, S. and Goyal, R. K. (2021) **Fuel Chemistry Theory and Practical**,1st Edition Aaryush Publications, Muzaffarnagar (U.P.)
2. Ahluwalia, V. K. and Aggarwal, R. **Comprehensive Practical Organic Chemistry, Preparation and Quantitative Analysis** ,University Press, New Delhi.

3. Sharma, R.K., Sidhwani,I.T.,Chaudhari,M.K. (2013),**Green Chemistry Experiments: A monograp**h, I.K. International Publishing House Pvt Ltd. New Delhi.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE –DSC 5: Periodic Properties and Chemical bonding

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Periodic Properties and Chemical bonding (DSC-5: Chemistry -II)	04	02	0	02	Class XII Pass	---

Learning Objectives

- The course discusses the periodicity in properties with reference to the s, p and d block, which is necessary in understanding their group chemistry.
- It provides basic knowledge about ionic, covalent and metallic bonding underlining the fact that chemical bonding is best regarded as a continuum between the three cases.
- It provides an overview of hydrogen bonding and van der Waal's forces which influence the melting points, boiling points, solubility and energetics of dissolution of compounds

Learning outcomes

By the end of the course, the students will be able to:

- Understand periodicity in ionization enthalpy, electron gain enthalpy, electronegativity and enthalpy of atomization.
- Understand variability in oxidation state, colour, metallic character, magnetic and catalytic properties and ability to form complexes
- Understand the concept of lattice energy using Born-Landé expression.
- Draw Born Haber Cycle and analyse reaction energies.
- Draw the plausible structures and geometries of molecules using VSEPR theory.
- Understand and draw MO diagrams (homo- & hetero-nuclear diatomic molecules).
- Understand the importance and applications of hydrogen and van der Wall bonding.

SYLLABUS OF DSC- 5

UNIT – I: Periodic Properties (12 Hours)

Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy, inert pair effect.

General group trends of s, p and d block elements with special reference to Ionization Enthalpy, Electron Gain Enthalpy, Electronegativity, Enthalpy of Atomization, oxidation state, colour, metallic character, magnetic and catalytic properties, ability to form complexes

UNIT – II: Chemical bonding (18 Hours)

Ionic Bonding: General characteristics of ionic bonding, Lattice Enthalpy and Solvation Enthalpy and their relation to stability and solubility of ionic compounds, Born-Lande equation for calculation of Lattice Enthalpy (no derivation), Born-Haber cycle and its applications, polarizing power and polarizability, Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.

Covalent Bonding: Valence Bond Approach, Hybridization and VSEPR Theory with suitable examples, Concept of resonance and resonating structures in various inorganic and organic compounds, Molecular Orbital Approach: Rules for the LCAO method, bonding, nonbonding and antibonding MOs and their characteristics for s-s, s-p and p-p combinations of atomic orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of s-p mixing) and heteronuclear diatomic molecules such as CO, NO and NO^+.

Brief introduction to Metallic Bonding, Hydrogen Bonding, van der Waal's Forces

Practical component – 60 Hours

Chemistry-II,

1. Preparation of standard solutions.
2. Estimation of Sodium carbonate with HCl.
3. Estimation of oxalic acid by titrating it with $KMnO_4$.
4. Estimation of Mohr's salt by titrating it with $KMnO_4$.
5. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.
6. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal and external indicators.
7. Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$.
8. Chromatographic separation of mixture of metal ions Cu^{2+}, Cd^{2+} or Ni^{2+}, Co^{2+}.
9. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using
    a. internal indicator
    b. external indicator
10. Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$.
11. Paper Chromatographic separation of mixture of metal ions
    a. Cu^{2+}, Cd^{2+}
    b. Ni^{2+} , Co^{2+}
12. Any suitable experiment (other than the listed ones) based upon neutralisation/redox reactions.

Essential/recommended readings

Theory:

9. Huheey, J.E.; Keiter, E.A., Keiter; R. L.; Medhi, O.K. (2009), **Inorganic Chemistry-Principles of Structure and Reactivity**, Pearson Education
10. Shriver, D.D.; Atkins, P.; Langford, C.H. (1994), **Inorganic Chemistry** 2nd Ed., Oxford University Press.

11. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A. (2010), **Inorganic Chemistry**, 5th Edition, W. H. Freeman and Company.
12. Lee, J.D.; (2010), **Concise Inorganic Chemistry**, Wiley India
13. Douglas, B.E.; McDaniel, D.H.; Alexander, J.J. (1994),**Concepts and Models of Inorganic Chemistry**, John Wiley & Sons.
14. Wulfsberg, G (2002), **Inorganic Chemistry**, Viva Books Private Limited.
15. Miessler, G.L.; Fischer P.J.; Tarr, D. A. (2014), **Inorganic Chemistry**, 5th Edition, Pearson.

Practical:

1. Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C. (1989), **Vogel's Textbook of Quantitative Chemical Analysis**, John Wiley and Sons.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – DSC 6: Mechanics

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Mechanics DSC - 6	4	2	0	2	Class XII pass with Physics and Mathematics as main subjects	Physics and Mathematics syllabus of class XII

Learning Objectives

This course reviews the concepts of mechanics learnt at school from a more advanced perspective and goes on to build new concepts. It begins with a review of vector algebra and ordinary differential equations. The students will learn Newton's laws of motion, conservation of momentum, conservation of energy, concept of simple harmonic motion, Newton's laws of gravitation, elasticity and the Special Theory of Relativity. They will be able to apply the concepts learnt to several real world problems.

Learning Outcomes

Upon completion of this course, students will be able to,

- Learn the laws of motion and their application to various dynamical situations.
- Understand the concept of conservation of momentum, angular momentum and energy. Their application to basic problems.
- Understand the motion of simple pendulum
- Understand the laws of gravitation and basic idea of global positioning system
- Understand the elastic properties
- Postulates of special theory of relativity, inertial and non-inertial frame of reference and their transformation, relativistic effects on the mass and energy of a moving body.

SYLLABUS OF DSC – 1

Vectors: Review of vector algebra. Scalar and vector product

(2 Hours)

Ordinary Differential Equations: First order homogeneous differential equations, second order homogeneous differential equation with constant coefficients

(4 Hours)

Brief review of Newton's laws of motion, dynamics of a system of particles, centre of mass, determination of centre of mass for continuous systems having spherical symmetry. Conservation of momentum and energy, work – energy theorem for conservative forces, force as a gradient of potential energy, angular momentum, torque, conservation of angular momentum

(9 Hours)

Idea of simple harmonic motion, differential equation of simple harmonic motion and its solution, kinetic energy and potential energy, total energy and their time average for a body executing simple harmonic motion

(4 Hours)

Newton's law of gravitation, motion of a particle in a central force field, Kepler's laws, weightlessness, geosynchronous orbit, basic idea of global positioning system

(4 Hours)

Elasticity: Concept of stress and strain, Hooke's law, elastic moduli, twisting torque on awire, tensile strength, relation between elastic constants, Poisson's ratio, rigidity modulus

(3 Hours)

Postulates of special theory of relativity, Lorentz transformation relations, length contraction, time dilation, relativistic transformation of velocity

(4 Hours)

PRACTICAL COMPONENT (60 Hours)

Every student should perform at least 06 experiments from the following list.

1) Measurements of length (or diameter) using vernier calliper, screw gauge and travellingmicroscope.
2) Determination of height of a building using a sextant.
3) Study of motion of the spring and calculate (a) spring constant and, (b) acceleration dueto gravity (g)
4) Determination of moment of inertia of a flywheel.
5) Determination of Young's modulus of a wire by Optical Lever Method.
6) Determination of modulus of rigidity of a wire using Maxwell's needle.
7) Determination of elastic constants of a wire by Searle's method.
8) Determination of value of g using bar pendulum.
9) Determination of value of g using Kater's pendulum.

References (for Laboratory Work):

1) Advanced practical physics for students, B. L. Flint and H. T. Worsnop, 1971, AsiaPublishing House.
2) Engineering practical physics, S. Panigrahi and B. Mallick, 2015, Cengage Learning India
3) Practical physics, G. L. Squires, 2015, 4/e, Cambridge University Press.
4) A text book of practical physics, I. Prakash and Ramakrishna, 11/e, 2011, Kitab Mahal.
5) B. Sc. practical physics, Geeta Sanon, R. Chand, 2016

Essential Readings:

FOR THEORY COMPONENT

1) Schaum's Outline of Vector Analysis, 2nd Edn., Murray Spiegel, Seymour Lipschutz, Tata McGraw-Hill, (2009)
2) An Introduction to Mechanics (2/e), Daniel Kleppner and Robert Kolenkow, 2014, Cambridge University Press.
3) Mechanics Berkeley Physics Course, Vol. 1, 2/e, Charles Kittel, et. al., 2017, McGraw Hill Education
4) Mechanics, D. S. Mathur and P. S. Hemne, 2012, S. Chand.

.**Suggestive Readings:**

1) University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
2) University Physics, H. D. Young and R. A. Freedman, 14/e, 2015, Pearson Education.
3) Fundamentals of Physics, Resnick, Halliday and Walker 10/e, 2013, Wiley.
4) Engineering Mechanics, Basudeb Bhattacharya, 2/e, 2015, Oxford University Press.

COMMON POOL OF GENERIC ELECTIVES
OFFERED BY DEPARTMENT OF CHEMISTRY

GENERIC ELECTIVES -12: Coordination and Organometallic Compounds

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Coordination and Organometallic Compounds (GE-2)	4	2	0	2	Class XII Pass	---

Learning Objectives

The Learning Objectives of this course are as follows:

- To introduce students to some important d-block metals and their compounds which they are likely to come across.
- To make students learn about organometallic compounds, a frontier area of chemistry providing an interface between organic and inorganic chemistry.
- To familiarize students with coordination compounds which find manifold applications in diverse fields.

Learning outcomes

By the end of the course, the students will be able to:

- Familiarize with different types of organometallic compounds, their structures and bonding involved.
- Understand the nature of Zeise's salt and compare its synergic effect with that of carbonyls.
- Identify important structural features of tetrameric methyl lithium and understand the concept of multicenter bonding in these compounds
- Apply 18-electron rule to rationalize the stability of metal carbonyls and related species
- Use IR data to explain the extent of back bonding in carbonyl complexes
- Understand the terms, ligand, denticity of ligands, chelate, coordination number and use standard rules to name coordination compounds
- Use Valence Bond Theory to predict the structure and magnetic behaviour of metal complexes and understand the terms inner and outer orbital complexes
- Understand the properties of coordination compounds and VBT and CFT for bonding in coordination compounds

- Explain the meaning of the terms Δ_o, Δt, pairing energy, CFSE, high spin and low spin and how
- CFSE affects thermodynamic properties like lattice enthalpy and hydration enthalpy

Theory:

Unit 1: Coordination Chemistry **4 Hours**

Brief discussion with examples of types of ligands, denticity and concept of chelate. IUPAC system of nomenclature of coordination compounds (mononuclear and binuclear) involving simple monodentate and bidentate ligands.

Unit 2:Bonding in coordination compounds **14 Hours**

Valence Bond Theory (VBT): Salient features of theory, concept of inner and outer orbital complexes of Cr, Fe, Co and Ni. Drawbacks of VBT.

Crystal Field Theory: Splitting of d orbitals in octahedral symmetry. Crystal field effects for weak and strong fields. Crystal field stabilization energy (CFSE), concept of pairing energy. Factors affecting the magnitude of Δ_o.

Spectrochemical series. Splitting of d orbitals in tetrahedral symmetry. Comparison of CFSE for octahedral and tetrahedral fields, tetragonal distortion of octahedral geometry. Jahn-Teller distortion, square planar coordination.

Unit 3: Organometallic Compounds **12 Hours**

Definition and classification with appropriate examples based on nature of metal-carbon bond (ionic, s, p and multicentre bonds). Structure and bonding of methyl lithium and Zeise's salt. Structure and physical properties of ferrocene. 18-electron rule as applied to carbonyls. Preparation, structure, bonding and properties of mononuclear and polynuclear carbonyls of 3d metals. π-acceptor behaviour of carbon monoxide (MO diagram of CO to be discussed), synergic effect and use of IR data to explain extent of back bonding.

Practicals: **60 Hours**

1. Gravimetry

Discuss basic principles of gravimetry (precipitation, co-precipitation and post precipitation, digestion, washing etc)

(i) Estimation of Ni(II) using dimethylglyoxime (DMG).
(ii) Estimation of copper as CuSCN.
(iii) Estimation of Al(III) by precipitating with oxine and weighing as Al(oxine)3 (aluminium oxinate).

2. Inorganic Preparations

(i) Schiff's base involving ethylenediamine and salicylaldehyde (or any other amine and aldehyde/ketone) and to check its purity using TLC.

(ii) Nickel/ Copper complex of the above prepared Schiff's base and its characterisation using UV/Vis spectrophotometer. The IR spectra also to be interpreted

(iii) tetraamminecopper (II) sulphate

(iv) potassium trioxalatoferrate (III) trihydrate.

(v) tetraamminecarbonatocobalt(III) nitrate

References:

Theory:

1. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A. (2010), **Shriver and Atkins Inorganic Chemistry**, W. H. Freeman and Company.
2. Miessler, G. L.; Fischer P.J.; Tarr, D.A. (2014), **Inorganic Chemistry**, Pearson.
3. Huheey, J.E.; Keiter, E.A., Keiter; R.L., Medhi, O.K. (2009), **Inorganic Chemistry-Principles of Structure and Reactivity**, Pearson Education.
4. Pfennig, B. W. (2015), **Principles of Inorganic Chemistry.** John Wiley & Sons.
5. Cotton, F.A.; Wilkinson, G. (1999), **Advanced Inorganic Chemistry** Wiley-VCH.

Practicals:

1. Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C. (1989), **Vogel's Textbook of Quantitative Chemical Analysis**, John Wiley and Sons.
2. Schiff Base Complex of Cu (II) with Antibacterial and Electrochemical Study, Arjun C. Bhowmick, Majharul I. Moim, Miththira Balasingam **, American Journal of Chemistry** 2020, 10(2): 33-37, DOI: 10.5923/j.chemistry.20201002.03

Keywords: Organometallic compounds, metal carbonyls, synergistic effect, Coordination compounds, VBT, Crystal field theory, Splitting of d levels, Dq

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVES -13: – CHEMISTRY OF OXYGEN CONTAINING FUNCTIONAL GROUPS AND THEIR APPLICATIONS TO BIOLOGY

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Chemistry of Oxygen containing Functional Groups and their Applications to Biology (GE-5)	4	2	0	2	Class XII Pass	----

Learning Objectives

- To teach the fundamental chemistry of oxygen containing functional groups.
- To establish these concepts typical reactions of alcohols, phenols, aldehydes, ketones, carboxylic acids and their derivatives.
- To make students understand the relevance of oxygen containing functional groups to biology and the importance of these compounds in real world.

Learning outcomes

By the end of the course, the students will be able to:

- Understand and explain the differential behavior of organic compounds based on reaction chemistry.
- Formulate the mechanism of organic reactions by recalling and correlating the fundamental properties of the reactants involved.
- Understand the applications of functional group chemistry to biology.

Syllabus - Theory:

Unit 1: Alcohols (upto 5 Carbon) **5 Hours**

Structure and classification of alcohols as 1^o, 2^o & 3^o, Reactions: Acidic character of alcohols and reaction with sodium, with HX (Lucas Test), esterification, oxidation (with PCC, alkaline $KMnO_4$, acidic $K_2Cr_2O_7$ and conc. HNO_3), Oppeneauer Oxidation, Biological oxidation Reactions

Unit 2: Phenols **4 Hours**

Acidity of phenols and factors affecting their acidity, Reactions: Electrophilic substitution reactions, *viz.* nitration, halogenation, sulphonation, Reimer-Tiemann reaction, Gattermann–Koch reaction, Houben-Hoesch condensation; Reaction due to OH group: Schotten-Baumann reaction

Unit 3: Aldehydes and Ketones (Aliphatic and Aromatic) **12 Hours**

Reactions: Nucleophilic addition, nucleophilic addition-elimination reaction including reaction with HCN, ROH, $NaHSO_3$, NH_2-G derivatives. Iodoform test, Aldol condensation and its biological application, Cannizzaro's reaction, Wittig reaction, Benzoin condensation, Clemmensen reduction, Wolff Kishner reduction, Meerwein-Pondorff Verley reduction, enzyme-catalyzed additions to α,β-unsaturated carbonyl compounds.

Unit 4: Carboxylic acids and their derivatives (Aliphatic and Aromatic) **9 Hours**

Reactions: Hell-Volhard Zelinsky reaction, acidity of carboxylic acids, effect of substitution on acid strength, Claisen condensation and its biological applications, decarboxylation in biological systems, relative reactivities of acid derivatives towards nucleophiles, activation of carboxylate ions for nucleophilic acyl substitution reactions in biological systems, Reformatsky reaction, Perkin condensation.

Practicals: : **60 Hours**

Preparations: (Mechanism of various reactions involved to be discussed) (Recrystallization, determination of melting point and calculation of quantitative yields to be done in all cases)

1. Oxime of aldehydes and ketones

2. 2,4-Dinitrophenylhydrazone of aldehydes and ketones

3. Aldol condensation using green method.

4. Benzoin condensation using Thiamine Hydrochloride as a catalyst.

5. Alkaline hydrolysis of amide/ester.

6. Benzoylation of one of the following amines (aniline, *o*-, *m*-, *p*-toluidines and *o*-, *m*-, *p*-anisidine) or one of the following phenols (*β*-naphthol, resorcinol, p-cresol) by Schotten-Baumann reaction.

7. Identification of functional group for monofunctional organic compounds (Alcohols, phenols, aldehydes, ketones, carboxylic acids).

References:

Theory:

1. Sykes, P. (2005), **A Guide Book to Mechanism in Organic Chemistry**, Orient Longman.
2. Eliel, E. L. (2000), **Stereochemistry of Carbon Compounds**, Tata McGraw Hill.
3. Morrison, R. N.; Boyd, R. N., Bhattacharjee, S.K. (2010), **Organic Chemistry**, 7th Edition, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Mehta B.; Mehta M. (2015), **Organic Chemistry**, PHI Learning Private Limited Bahl,
5. Bahl, A., Bahl, B. S. (2012), **Advanced Organic Chemistry**, S. Chand.
6. Bruice, Paula Y. (2020), **Organic Chemistry**, 8th Edition, Pearson.

Practicals:

1. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. (2012), **Vogel's Textbook of Practical Organic Chemistry**, Pearson.
2. Mann, F.G.; Saunders, B.C. (2009), **Practical Organic Chemistry**, Pearson Education.

Keywords: Alcohols, Lucas Test, Phenol, Aldehydes, Ketones, Nucleophilic addition, nucleophilic addition – elimination, Cannizzaro's reaction, Wittig reaction, Benzoin condensation, Enzyme-catalysed reaction, Carboxylic acid, Claisen condensation

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVES-14: MOLECULES OF LIFE

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Molecules of Life (GE-6)	4	2	0	2	Class XII Pass	----

Learning Objectives

- To deliver information about the chemistry of carbohydrates, proteins & enzymes and its relevance in the biological system using suitable examples.
- To place key emphasis on understanding the structural principles that govern reactivity/physical /biological properties of biomolecules as opposed to learning structural details.

Learning outcomes

By the end of the course, the students will be able to:

- Learn and demonstrate how the structure of biomolecules determines their chemical properties, reactivity and biological uses.
- Gain an insight into the mechanism of enzyme action and inhibition.
- Understand the basic principles of drug-receptor interaction and SAR.

Syllabus - Theory:

Unit 1: Carbohydrates **12 Hours**

Classification of carbohydrates, reducing and non-reducing sugars, biological functions, general properties and reactions of glucose and fructose, their open chain structure, epimers, mutarotation and anomers, reactions of monosaccharides, determination of configuration of glucose (Fischer proof), cyclic structure of glucose. Haworth projections. Cyclic structure of fructose. Linkage between monosaccharides: structure of disaccharides (sucrose, maltose, lactose) and polysaccharides (starch and cellulose) excluding their structure elucidation.

Unit 2: Amino Acids, Peptides and Proteins **10 Hours**

Classification of amino acids and biological uses of amino Acids, peptides and proteins. Zwitterion structure, isoelectric point and correlation to acidity and basicity of amino acids. Determination of primary structure of peptides, determination of N-terminal amino acid (by

Edman method) and C– terminal amino acid (with carboxypeptidase enzyme). Synthesis of simple peptides (up to dipeptides) by N-protection (t-butyloxycarbonyl) & C-activating groups (only DCC) and Merrifield solid phase synthesis, Overview of primary, secondary, tertiary and quaternary structure of proteins, denaturation of proteins.

Unit 3: Enzymes and correlation with drug action **08 Hours**

Classification of enzymes and their uses (mention Ribozymes). Mechanism of enzyme action, factors affecting enzyme action, Coenzymes and cofactors and their role in biological reactions, specificity of enzyme action (including stereospecificity), enzyme inhibitors and their importance, phenomenon of inhibition (Competitive and non-competitive inhibition including allosteric inhibition). Drug action-receptor theory. Structure – activity relationships of drug molecules, binding role of –OH group, $-NH_2$ group, double bond and aromatic ring.

Practicals: **(60 Hours)**

1. Estimation of glucose by Fehling's solution.
2. Determination of total sugar content by ferricyanide method (volumetric/colorimetric method).
3. Study of the titration curve of glycine.
4. Estimation of proteins by Lowry's method.
5. Study of the action of salivary amylase on starch under optimum conditions.
6. Qualitative tests for amino acids, proteins and carbohydrates.
7. Separation and identification of mixture of sugars by paper chromatography.

References:

Theory:

1. Finar, I. L. **Organic Chemistry** (Volume 1 & 2), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Morrison, R. N.; Boyd, R. N., Bhattacharjee, S.K. (2010), **Organic Chemistry**, 7th Edition, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Berg, J. M.; Tymoczko, J. L.; Stryer, L. (2019), **Biochemistry**, 9th Ed., W. H. Freeman Co Ltd.

Practicals:

1. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. (2012), **Vogel's Textbook of Practical Organic Chemistry**, Pearson.
2. **Manual of Biochemistry Workshop**, 2012, Department of Chemistry, University of Delhi.

Teaching Learning Process:

- Chalk and black board method. Along with pedagogy of flipped classroom

- Certain topics like mechanism of enzyme action and enzyme inhibition can be taught through audio-visual aids.
- Students should be encouraged to participate actively in the classroom through regular presentations on curriculum-based topics, peer assessment, designing games based on specific topics etc.
- As the best way to learn something is to do it yourself, practicals are planned in such a way so as to reinforce the topics covered in theory.

Assessment Methods:

- Graded assignments
- Class tests and Quizzes
- Class seminars by students on course topics with a view to strengthening the content through width and depth
- Continuous evaluation for the practicals
- End semester university theory and practical examination.

Keywords: Carbohydrates, point, Amino acids, Enzymes, SAR, Drug Receptor Theory

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVES -15 : CHEMICAL KINETICS AND PHOTOCHEMISTRY

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Chemical Kinetics and Photochemistry (GE-8)	4	2	0	2	Class XII Pass	-----

Learning Objectives

- To make students learn about the fundamentals of chemical kinetics, rates of chemical reactions, complex reactions, theories of reaction rate and the laws of photochemistry aimed at understanding electronic transitions upon irradiation of electromagnetic radiation in UV-Vis region.

Learning outcomes

By the end of the course, the students will be able to:

- Understand the concept of rate of a reaction, order and molecularity of a reaction, various factors affecting the rate and theories of reaction rates.
- Students will be able to apply the learnt concepts in studying the reaction kinetics of various reactions.
- Understand the basic concepts of photochemistry, photochemical and photosensitized reactions and their role in biochemical systems.

Syllabus - Theory:

Unit 1: Chemical Kinetics **20 Hours**

The concept of reaction rates, effect of temperature, pressure, catalyst and other factors on reaction rates. Order and molecularity of a reaction, derivation of integrated rate equations for zero, first and second order reactions (both for equal and unequal concentrations of reactants), half–life of a reaction, general methods for determination of order of a reaction. kinetics of complex reactions (integrated rate expressions up to first order only): (i) Opposing reactions (ii) parallel reactions and (iii) consecutive reactions and their differential rate equations (steady-state approximation in reaction mechanisms). Concept of activation energy and its calculation from Arrhenius equation. Theories of reaction rates: Collision theory and activated complex theory of bi-molecular reactions. Comparison of the two theories (qualitative treatment only)

Unit 2: Photochemistry **10 Hours**

Characteristics of electromagnetic radiation, Jablonski Diagram. Lambert-Beer's law and its limitations, physical significance of absorption coefficients. Laws of photochemistry, quantum yield, actinometry, examples of low and high quantum yields, photochemical equilibrium and the differential rate of photochemical reactions, photosensitized reactions, quenching. Role of photochemical reactions in biochemical processes.

Practicals: **(60 Hours)**

Chemical Kinetics

Study the kinetics of the following reactions by integrated rate method:

a) Acid hydrolysis of methyl acetate with hydrochloric acid.

b) Compare the strength of HCl and H2SO4 by studying the kinetics of hydrolysis methyl acetate.

c) Initial rate method: Iodide-persulphate reaction

d) Integrated rate method: Saponification of ethyl acetate.

e) Study the reaction kinetics of Iodination of acetone.

References:

Theory:

1. Castellan, G.W. (2004), **Physical Chemistry**, Narosa.

2. Kapoor, K.L. (2015), **A Textbook of Physical Chemistry**, Vol 5, 6th Edition, McGraw Hill Education.

3. Kapoor, K.L. (2013), **A Textbook of Physical Chemistry**, Vol 6, 3rd Edition, McGraw Hill Education.

Practicals:

1. Khosla, B.D.; Garg, V.C.;Gulati, A.(2015), **Senior Practical Physical Chemistry**, R. Chand & Co.

Teaching Learning Process:

- Teaching Learning Process for the course is visualized as largely student-focused
- Transaction through an intelligent mix of conventional and modern methods
- Engaging students in cooperative learning.
- Learning through quiz design.
- Problem solving to enhance comprehension.

Assessment Methods: Assessment will be done on the basis of regular class test, presentations and assignments as a part of internal assessment during the course as per the curriculum. End semester university examination will be held for both theory and practical. In practical, assessment will be done based on continuous evaluation, performance in the experiment on the date of examination and viva voce.

Keywords: Rate Law, Rate constant. Arrhenius Equation, Lambert-Beer’s law, Jablonski Diagram

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVES -16: BASICS OF POLYMER CHEMISTRY

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Basics of Polymer Chemistry (GE-10)	4	2	0	2	Class XII Pass	-----

Learning Objectives

- To help the student to know about the synthesis, properties and applications of polymers.

Learning outcomes

By the end of the course, the students will be able to:

- Know about classification of polymeric material.
- Learn about different mechanisms of polymerization and polymerization techniques
- Evaluate kinetic chain length of polymers based on their mechanism
- Differentiate between polymers and copolymers
- Learn about different methods of finding out average molecular weight of polymer.
- Differentiate between glass transition temperature (Tg) and crystalline melting point (Tm)
- Learn properties and applications of various useful polymers in our daily life

Syllabus Theory:

Unit 1: Introduction to polymers **10 Hours**

Different schemes of classification of polymers, Polymer nomenclature, configuration and conformation of polymers, Molecular forces and chemical bonding in polymers, Texture of Polymers

Functionality and its importance:

Criteria for synthetic polymer formation, basic methods of polymerization processes and their mechanism: addition, condensation, Relationships between functionality, extent of reaction and degree of polymerization.

Unit 2: Properties of Polymers **10 Hours**

Glass transition temperature (Tg) and determination of Tg, Free volume theory, WLF equation, Factors affecting glass transition temperature (Tg).
Crystallization and crystallinity: Determination of crystalline melting point and degree of crystallinity,
Morphology of crystalline polymers, Factors affecting crystalline melting point.
Molecular weight distribution and determination of molecular weight of polymers (Mn, Mw, etc.) by end group analysis, viscometry and osmotic pressure methods. Molecular weight distribution and its significance.

Unit 3: Preparation, properties and applications **10 Hours**

Brief introduction to preparation, structure, properties and application of the following polymers: polyolefins, polystyrene and styrene copolymers, poly(vinyl chloride), poly(vinyl acetate), acrylic polymers, fluoro polymers, polyamides and related polymers. Phenol formaldehyde resins (Bakelite, Novolac), polyurethanes, silicone polymers, polydienes, Polycarbonates, Conducting Polymers: polyacetylene, polyaniline, poly(p-phenylene sulphide, polypyrrole, polythiophene

Practicals: **(60 Hours)**

Polymer Synthesis

1. Free radical solution polymerization of styrene (St) / Methyl Methacrylate (MMA)/MethylAcrylate (MA).
2. Preparation of nylon 6,6
3. Redox polymerization of acrylamide
4. Precipitation polymerization of acrylonitrile
5. Preparation of urea-formaldehyde resin
6. Preparations of novalac resin/resole resin.
7. Microscale Emulsion Polymerization of Poly(methylacrylate).

Polymer characterization

1. Determination of molecular weight of polyvinyl propylidene in water by viscometry.
2. Determination of the viscosity-average molecular weight of poly(vinyl alcohol) (PVOH) and the fraction of head-to-head monomer linkages in the polymer.
3. Determination of molecular weight by end group analysis of polymethacrylic acid.

Polymer analysis

1. Estimation of the amount of HCHO in the given solution by sodium sulphite method.
2. Determine the melting point of crystalline polymer.
3. Measurement of glass transition temperature, T_g.s

References:

Theory:

1. Carraher,C. E. Jr. (2013), **Seymour's Polymer Chemistry**, Marcel Dekker, Inc.
2. Odian, G. (2004), **Principles of Polymerization**, John Wiley.
3. Billmeyer, F.W. (1984), **Text Book of Polymer Science**, John Wiley.
4. Ghosh, P. (2001), **Polymer Science & Technology**, Tata Mcgraw-Hill.
5. Lenz, R.W. (1967), **Organic Chemistry of Synthetic High Polymers**, Intersecience (Wiley).

Practical:

1. Allcock, H.R.; Lampe, F. W.; Mark, J. E. (2003), **Contemporary Polymer Chemistry**, Prentice-Hall.
2. Fried, J.R. (2003), **Polymer Science and Technology**, Prentice-Hall.
3. Munk, P.; Aminabhavi, T. M. (2002), **Introduction to Macromolecular Science,** John Wiley & Sons.
4. Sperling, L.H. (2005), **Introduction to Physical Polymer Science**, John Wiley & Sons.

Teaching Learning Process:

- Student centred teaching Learning process.
- Blend of conventional blackboard teaching and modern teaching learning tools
- Focus on real life applications of concepts
- Problem solving and quizzes for enhanced understanding of the concepts
- Engaging students in collaborative learning.
- Pre-lab learning of theoretical concept of the experiment.
- Performing the experiment, recording the data, calculating the result.
- Interpreting the result.
- Comparing the results of the class.
- Discussing the sources of error.

Assessment Methods:

- Class Tests at Periodic Intervals.
- Written assignment(s)
- Continuous evaluation of laboratory work and record file.
- Oral assessment, quizzes.
- Mock practical examination.
- Semester end University examination.

Keywords: Bonding, Texture, Polymerization, Crystallization, Properties, Applications.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVES 17: CHEMISTRY: MOLECULAR MODELLING, ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Chemistry: Molecular Modelling, Artificial Intelligence and Machine Learning (GE-14)	4	2	0	2	Class XII Pass	----

Learning Objectives

- To make students familiar with modernscientific machine (programming) language i.e., Python, Artificial Intelligence (AI) & Machine Learning (ML) and their potential applications in chemistry.
- To provide elementary ideas of the techniques prevailing in the field of AI and ML and their applications to research problems especially related to research and development of new materials and pharmaceutical compounds with desired properties.

Learning outcomes

By the end of the course, the students will be:

- Conversant with the Python Programming Language.
- Familiar with Elementary techniques of AI and ML
- Able to apply techniques of AI & ML in basic problems of research in some important areas of research in Chemistry.

Syllabus Theory:

Part A: Molecular Modelling

Introduction to computational chemistry: **7 Hours**

Overview of Computational Methods in Chemistry (Ab initio, DFT, Semi- empirical, Molecular Mechanics

Potential Energy Surfaces **4 Hours**

The concept of Potential energy surface, Intrinsic Reaction Coordinates, Stationary points, Equilibrium points – Local and Global minima, Geometry optimization and energy minimization.

Molecular Mechanics **4 Hours**

Force Fields (A brief idea of a basic force field), Elementary idea of MM1, MM2, MM3, MM4, MM+, AMBER etc. A brief Idea of Molecular Docking

Part B: Artificial Intelligence & Machine learning in Chemistry **15 Hours**

An overview of computationally readable and processible representationof molecules, e.g., SMILES, mol files. Chemical space and access to chemical databases. Statistical treatment of data: regression analysis andtypes of regression. Elementary Idea of Quantitative structure-activity relationship (QSAR).

An insight into Artificial Intelligence & Machine learning and potentialareas of applications in chemistry. Dimensional reduction; Principal Component Analysis (PCA) and the importance and necessity of nonlinearity in Artificial Intelligence.

Genetic algorithm, basics of random mutation hill climbing (RMHC) and simulated annealing.

Practicals: **(60 hours)**

Molecular Modeling based Exercise

1) Write the Z-Matrix of a given set of molecules.

2) Carry out geometry optimisation on H_2O, H_2S, H_2Se molecules and compare the optimized bond angles and dipole moments from the results obtained. Obtain the ESP-mapped density surfaces and interpret the results obtained with reference to bonding in these molecules.

Suggestive: A comparative analysis of results of the above exercise may be carried out using different quantum mechanicalmethods.

3) Calculate the energy of the following chemical species andarrange them in order of increasing stability.

1-hexene, 2-methyl-2-pentene, (E)-3-methyl-2-pentene, (Z)-3- methyl-2-pentene, and 2,3-dimethyl-2-butene in order of increasing stability.

4) Carry out the geometry optimisation on the following chemical species and compare the shapes and dipole moments of the molecules.

1-butanol, 2-butanol, 2-methyl-1-propanol, and 2-methyl-2- propanol.

Correlate the computationally obtained values of the dipolemoments with the experimental values of the boiling points: (118ºC, 100 ºC, 108 ºC, 82 ºC, of 1-butanol, 2-butanol, 2-methyl-1- propanol, and 2-methyl-2- propanol respectively).

5) Based on the implicit electronic structure calculations, determine the heat of hydrogenation of Ethene.

6) Based on the calculations of enthalpies of the participatingchemical species on

optimized geometry of the molecules, calculate the reaction enthalpy at 298 K for the following,industrially important reactions:

$CH_4 + H_2O \rightarrow CO + 3H_2$ (steam reforming of methane)

$N_2 + 3\ H_2 \rightarrow 2NH_3$ (Haber-Bosch process)

7) Carry out geometry optimisation and determine the energy of the participating chemical species in the following reactions Using these results calculate the resonance energy of thiophene.
8) Carry out geometry optimization & energy calculations on the following species and obtain Frontier Molecular Orbitals. Visualize the Molecular Orbitals of these species and interpret the results for bonding in these molecules.

Benzene, Naphthalene, and Anthracene.

9) Compare the gas phase basicities of the methylamines by comparing the enthalpies of the following reactions:
10) On the basis of results of geometry optimization and energy calculations, determine the enthalpy of isomerization of cis andtrans 2-butene.
11) QSAR based exercise on problems of interest to chemist.
12) Perform a conformational analysis of butane. Plot the graph between the angle of rotation and the energy of the conformers using spreadsheet software.
13) Compute the resonance energy of benzene by comparison of its enthalpy of hydrogenation with that of cyclohexene.
14) Perform a geometry optimization followed by a frequency assessment (opt+freq keyword) using the B3LYP method and 6-31-G(d) basis set on a given set of small molecules i.e. BH_3, CH_4.

Suggestive: A greater number of molecules may be studied as per instructions received from the concerned teacher.

15) Based on the fundamentals of conceptual DFT calculate the ionization potential (IP), electron affinity (EA), electronegativity and electron chemical potential of a given set of molecules.
16) Perform molecular docking of Sulfonamide-type D-Glu inhibitor into MurD active site using Argus lab.

Artificial Intelligence (AI) and Machine Learning (ML) based exercise on problems of interest to chemist

17. Travelling salesman problem and electrical circuit design (minimization of path-length).
18. Genetic algorithm, in solving matrix form of linear equations
19. Non-linear least-square fitting problem.
20. Particle Swarm Optimization on the sphere function.

Important Instruction Note on working approach:

- A student is required to perform/investigate a minimum of 10 exercises in total.
- The exercises mentioned above will be performed by the student strictly in accordance with the instructions received and only under the supervision of the teacher concerned.
- Any other exercise may be carried out with prior permission, input, discussion and instructions received from the teacher concerned.

References:

1. Lewars, E. (2003), **Computational Chemistry**, Kluwer academicPublisher.
2. Cramer, C.J. (2004), **Essentials of Computational Chemistry**, John Wiley & Sons.
3. Cartwright C.; Kharma N., (2008), **Using artificial intelligence in chemistry and biology**, First Edition, CRC Press Taylor & Francis Group
4. Hippe; Z., **Artificial Intelligence in Chemistry: Structure Elucidation and Simulation of Organic Reactions**, (1991) Academic Press, Elsevier
5. Soft Computing in Chemical and Physical Sciences A Shift in Computing Paradigm (Kanchan Sarkar, Sankar Prasad Bhattacharyya) (z-lib.org)
6. Understanding Properties of Atoms, Molecules and Materials (PRANAB. SARKAR, Sankar Prasad Bhattacharyya) (z-lib.org)

Web Resources:

1. https://www.afs.enea.it/software/orca/orca_manual_4_2_1.pdf
2. https://dasher.wustl.edu/chem430/software/avogadro/learning-avogadro.pdf
3. http://www.arguslab.com/arguslab.com/ArgusLab.html
4. https://barrett- group.mcgill.ca/tutorials/Gaussian%20tutorial.pdf
5. https://gaussian.com/techsupport/
6. https://gaussian.com/man/
7. https://gaussian.com/wp-content/uploads/dl/gv6.pdf
8. https://dasher.wustl.edu/chem478/software/spartan-manual.pdf
9. http://www.mdtutorials.com/gmx/
10. https://vina.scripps.edu/manual/

Teaching Learning Process: Hands-on laboratory exercises Conventional teaching learning method. Engaging students in collaborative learning

Keywords: Molecular Modeling, Potential Energy Surface (PES), Geometry Optimization, Frequency calculation, Artificial Intelligence, Machine Learning, Nural Networks, Genetic Algorithm.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVES 18: ROLE OF METALS IN MEDICINES

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Role of Metals in Medicines (GE-16)	4	2	0	2	Class XII Pass	----

Learning Objectives

- To make the learners familiar about role of metal ions in some commercially available medicines.

Learning outcomes

By the end of this course student will be able to learn:

- Role of metal ions in various biomolecules and their functions.
- Role of metals in commercially available medicines and their functions

Syllabus Theory:

Unit 1: Bio role of Metals **04 Hours**

Brief introduction of following metals in biological system

Fe, Cu, Zn, Mn, Cr(III), V, Mo, W, Co, Ni, Na, K, Mg and Ca

Chemical structure, Commercial name, Name of the disease it is made for and its brief mechanism of action shall be taught for all the mentioned metals below.

Unit 2: Diagnostic and therapeutic agents **08 Hours**

Diagnostic and therapeutic agents with Pt (Cisplatin) and Ga for cancer, Au (auranofin) for arthritis and V for diabetes.

Unit 3: Metals in drugs **06 Hours**

Li_2CO_3 (Camcolit) for manic-depressive illness, $NaHCO_3$ (Alka-seltzer) for heartburn, $Al(OH)_3$ (Gaviscon) for heartburn, As (melarsoprol) for sleeping sickness, Bi subsalicylate (pepto-Bismol) for heartburn and diarrhea, Bi subcitrate (De-nol) peptic ulcer, Zinc oxide with Fe_2O_3 (Calamine lotion) as antimicrobial agent.

Unit 4: Metals in Multivitamins **06 Hours**

Cyanocobalamin (Co), Ferrous fumerate (Fe), Magnesium oxide (Mg), Zinc Sulfate (Zn), Manganese sesulphate (Mn), Copper Sulfate (Cu), Sodium selenite (Se) and Chromium trichloride (Cr).

Unit 5: Radiopharmaceuticals and MRI contrast agents **06 Hours**

^{99m}Tc for heart, brain and bone imaging, ^{123}I radiopharmaceuticals, $BaSO_4$for X-ray contrast agent, Gd (III) for MRI contrast agents.

Practicals: **(60 hours)**

Volumetric titrations:

1. To estimate the acidity of commercially available antacids.
2. To estimate the concentration of Fe in commercially available medicines.
3. To estimate the concentration of Ca in commercially available medicines.
4. To estimate the strength of carbonate in tablets containing Li_2CO_3
5. To estimate the sodium bicarbonate in synthetic/commercially available drug.
6. To estimate the zinc and iron present in Calamine lotion.
7. To estimate the Mg present in multivitamins.

References:

1. **Metals in Medicine**, John Wiley & Sons Ltd, Nov 2009
2. Chapter-9, **Metals in Medicine**, Stephen J. Lippard
3. Jones, Chris and Thornback, John, **Medicinal applications of coordination chemistry**, Cambridge, UK: Royal Society of Chemistry, 2007

Teaching Learning Process:

- Hands-on laboratory exercises
- Conventional teaching learning method. Engaging students in collaborative learning

Assessment Methods:

- Continuous evaluation of laboratory work and record file. Oral assessment, quizzes.
- Presentation on lab practices.
- Semester end examination.

Key words: Diagnostic, therapeutic agents, multivitamins, radiopharmaceuticals and MRI contrast agents.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVES -19: ENERGY AND THE ENVIRONMENT

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Energy and the Environment (GE-17)	4	3	0	1	Class XII Pass	---

Learning Objectives

- To develop basic understanding of energy, issues related to energy, importance of energy in terms of economy, health and the environment.
- To understand different sources of energies, renewable and non-renewable sources of energy. To understand the importance of green fuels.
- To make the students understand the adverse effect of pollution, and possible remediations.

Learning Outcomes

By the end of this course student will be able to learn:

- Describe basic energy concepts
- Account for conventional and renewable energy technologies and their application
- Reflect and evaluate the environmental impact of energy production and the relationship between energy production, consumption and climate change
- Reflect on energy costs, analyse the consequences of today's energy consumption
- Efficient use of energy, water and other resources, Use of renewable energy, such as solar energy
- Pollution and waste reduction measures, and the enabling of re-use and recycling
- Good indoor environmental air quality, Use of materials that are non-toxic, ethical and sustainable
- Consideration of the environment in design, construction and operation

Syllabus Theory:

Unit 1: **13 Hours**

Introduction, chemistry and energy, conversion of chemical energy to electrical energy, Carbon cycle, Greenhouse gases, Global warming and climate change, Carbon footprint, zero-carbon or low-carbon energy. Electrical energy and steam energy, Energy Alternatives, Hidden Costs of Energy.

Unit 2: **10 Hours**

Production methods for electric power: Non-Renewable (conventional) sources of energy: Fossil fuels: Coal, petroleum and Natural gas. Energy transformation. Renewable energy sources: solar, hydropower, wind, geothermal, wave, ocean thermal, tidal, ocean currents, nuclear energy, biomass.

Unit 3: **12 Hours**

Production methods for electric power: Renewable (green) energy, conversion and storage systems. Nuclear fusion, Hydrogen fuels, photovoltaic solar cells, hydroelectric. Sustainable energy, biomass, Biofuels, production of biofuels, advantages, blending of biofuels with conventional fuels, Carbon Capture and Reuse, Waste to Energy Technologies.

Unit 4: **10 Hours**

Air Pollution, Urban and Indoor Air Pollution, Pollution and waste reduction measures, chemical remediation of air pollution. Effect of pollution on health and economy.

Practicals: **(30 Hours)**

Tutorials

1. Conversion of biomass to biofuels (2-3 different biofuels)
2. Working on solar cell model.
3. Working on wind turbine model.
4. Working on geothermal energy model.
5. Working on hydroelectric plant model.
6. Presentations by students

References:

Theory

1. Rao, C S., **Environment pollution control Engineering**, New Age International reprint 2015, 2nd edition
2. Bharucha, E., **Textbook of Environmental Studies**, Universities Press (2005)
3. Wright, R.T., **Environmental Science-Towards a sustainable Future**, Prentice Hall (2008) 9th edition.
4. Ahluwalia, V. K., **Energy and Environment**, The Energy and Resources Institute (TERI) (2019).

References:

Practicals

- Challapalli Narayan Rao, **Practical approach to implementation of Renewable Energy Systems,** Evincepub Publishing, 2022

Keywords: Energy, Renewable and non-renewable energy resources, Synthetic fuels, Biofuels, Carbon footprint, air pollution, remediation, pollution related health and economy.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVES -20 : CHEMISTRY OF FRAGRANCES AND FLAVOURS: AN INDUSTRY'S PERSPECTIVE

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Chemistry of Fragrances and Flavours: An Industry's Perspective (GE-18)	4	3	0	1	Class XII Pass	----

Learning Objectives

- To make the students understand the applications of chemistry in the world of flavours and fragrances. The use of fragrance is ubiquitous and is a global human phenomenon. Over the course of time, countless numbers of flavors and fragrances have found their way into everyday life, notably into foods, beverages and confectionery items; into personal care products (soaps, toothpastes, mouthwashes, deodorants, bath lotions and shampoos), perfumes, and other cosmetics as well as pharmaceutical formulations. Indeed, flavors and aromas are added to make such products more attractive or to mask the taste or smell of less pleasant ones.

Learning Outcomes

By the end of this course student will be able to learn:

- Synthesis of various fragrance and flavour ingredients
- Formulation methods, how different factors affects the formulation process in Fragrance and Flavour industry
- Uphold safety regulation and execute quality processes
- Quality control in manufacturing process, legal aspects, classification of odour and odorants.
- Different methods used for separation, purification and isolation of perfumes and flavours like distillation, extraction, crystallization, etc.

Syllabus Theory:

Unit 1: Fragrances **18 Hours**

- Introduction to fragrances, types of fragrances (Fragrance families and classification)
- History of perfumes, Perfumery raw materials, classification of odour, odour type and odorants
- India in the context of Fragrance Industry
- ABCs of perfumery, odour aspects of perfumes, fragrance pyramid, fragrance families
- Some basic chemical knowledge to provide a better understanding of the structure of molecules possessing a sensory power, The volatility and solubility of sensory molecules
- Chemistry of aromatic compounds in perfume making, Composition of fragrances
- Current trends in fragrances, sensory analysis of different products
- Study of the raw materials used in perfumery (origin, extraction method, and olfaction)
- Key chemical reactions for conversion of raw materials to fragrances
- Extraction of essential oils used in perfumery
- Difference between alcohol and oil-based perfumes
- Outline of health, safety and sustainability parameters in perfumer

Unit 2: Sustainable Fragrance by Design **4 Hours**

- The challenges of sustainability and how it impacts the industry
- Sustainability charter
- Green chemistry principles
- Commitment to Biodiversity

Unit 3: Flavours **18 Hours**

- Introduction to flavours, types of flavours, flavour raw materials
- Understanding of terms like, Flavour and Flavouring agents. Attributes of flavour, taste, odour, odour stimulation, basic tastes and the human olfactory system.
- Stability of flavour in food, sensory evaluation of flavours in foods, Various flavour formulation
- Systematic approach to understanding flavour formation during food processing, food matrix, interaction of added flavours
- Flavour enhancers, modifiers, precursors, suppressors, solvents.
- Key chemical reactions for conversion of raw materials to flavours
- Forms of flavour and the manufacturing processes involving all types of flavours. Aroma recovery during processing.
- Biogenesis of flavours in fruits and vegetables, reaction flavours, off flavours.
- Stability of flavor in food, sensory evaluation of flavours in foods
- Selection and application of flavours in foods and beverages
- Legal aspects (natural flavours and natural flavouring substances, nature identical flavouring substances, artificial flavouring substances), and the FSSA act.

Unit 4: Extraction, Isolation and Purification of Perfumes and Flavour Compounds

05 Hours

- Extraction techniques for the separation of volatile oils from natural source-including. Distillation, Evaporation, Crystallization and Adsorption, supercritical fluid extraction methods of isolation of important ingredients

Practicals: **(30 hours)**

1. Extraction of D-limonene from orange peel using liquid CO_2.
2. Extraction of caffeine from coffee beans using liquid CO_2.
3. Extraction of essential oils from lemon using steam distillation
4. Extraction of essential oils from lemon using liquid CO_2.
5. Extraction of essential oils from fragrant flowers.
6. Determination of esters by Thin Layer Chromatography
7. Memorisation of different raw materials used in perfumery, perfume language, Memorisation of perfumes
8. Testing up of different flavours
9. Analysis of spectra of perfume formulations.

References:

1. Arctander, S. (2008), **Perfume and flavour materials of Natural origin,** Allured Publishing Corporation, USA
2. Arctander, S. (2017), Volume I and II, **Perfume and Flavour Chemicals**, (Aroma Chemicals), Allured Publishing Corporation, USA
3. Curtis,T.; Williams, D. C.(2001) 2nd Edition, **An Introduction to Perfumery**, Micelle Press, USA.
4. Sell,C. (2008), **Understanding Fragrance Chemistry,** Allured Publishing Corporation, USA
5. Calkin,R.R., Jellinek, J.S., **Perfumery: Practice and Principles,** John Wiley & Sons Inc.
6. Gimelli, S.P. (2001), **Aroma Science,** Micelle Press, USA
7. Arctander, S. (2019), **Perfume and Flavour Materials of Natural Origin,** Orchard Innovations
8. https://www.beyondbenign.org/lessons/essential-oil-extraction-using-liquid-co2/

Keywords: Fragrances, Flavours, pharmaceutical formulation, distillation, extraction techniques

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVES -21 : GREEN CHEMISTRY

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Green Chemistry (GE-20)	4	2	0	2	Class XII Pass	----

Learning Objectives

Huge rise in environmental pollution, depleting resources, climate change, ozone depletion, heaps and heaps of landfills piling up has forced the society to become more and more environmentally conscious. Future chemists and innovators are compelled to work towards sustainable practices. Green chemistry has arisen from these concerns. It is not a new branch of chemistry but helps to improve the creative and innovative thinking in undergraduate students. Green chemistry is a way to boost profits, increase productivity and ensure sustainability with absolute zero waste. Innovations and applications of green chemistry in education have helped companies to gain environmental benefits as well as to achieve economic and societal goals also. Undergraduate students are the ultimate scientific community of tomorrow. Training them to practice chemistry in the safest way possible is key towards safe working conditions in the laboratories as well as the chemical industry and extends to society in a sustainable future for the planet.

Learning Outcomes:

By the end of this course, students will be able to:

- Understand the twelve principles of green chemistry and also build the basic understanding of toxicity, hazard and risk related to chemical substances.
- Calculate atom economy, E-factor and relate them in all organic synthesis
- Appreciate the use of catalyst over stoichiometric reagents
- Learn to use green solvents, renewable feedstock and renewable energy sources for carrying out safer chemistry
- Appreciate the use of green chemistry in problem solving skills and critical thinking to innovate and find solutions to environmental problems.
- Learn to design safer processes, chemicals and products through understanding of inherently safer design (ISD)
- Appreciate the success stories and real-world cases as motivation for them to practice green chemistry

Syllabus :

Unit 1: Introduction **08 Hours**

Definition of green chemistry and how it is different from conventional chemistry and environmental chemistry.

• Need of green chemistry

• Importance of green chemistry in- daily life, Industries and solving human health problems (four examples each).

• A brief study of Green Chemistry Challenge Awards (Introduction, award categories and study about five last recent awards).

Unit 2: Twelve Principles of Green Chemistry **12 Hours**

The twelve principles of the Green Chemistry with their explanation, Special emphasis on the following:

• Prevention of waste / byproducts, pollution prevention hierarchy.

• Green metrics to assess greenness of a reaction: environmental impact factor, atom economy and calculation of atom economy.

• Green solvents-supercritical fluids, water as a solvent for organic reactions, ionic liquids, solvent less reactions, solvents obtained from renewable sources.

• Catalysis and green chemistry- comparison of heterogeneous and homogeneous catalysis, biocatalysis, asymmetric catalysis and photocatalysis.

• Green energy and sustainability.

• Real-time analysis for pollution prevention.

• Prevention of chemical accidents, designing greener processes, inherent safer design, principle of ISD "What you don't have cannot harm you", greener alternative to Bhopal Gas Tragedy (safer route to carcarbaryl) and Flixiborough accident (safer route to cyclohexanol) subdivision of ISD, minimization, simplification, substitution, moderation and limitation

Unit 3: **10 Hours**

The following Real-world Cases in green chemistry should be discussed: Surfactants for carbon dioxide – replacing smog producing and ozone depleting solvents with CO_2 for precision cleaning and dry cleaning of garments. Designing of environmentally safe marine antifoulant. Rightfit pigment: Synthetic azo pigments to replace toxic organic and inorganic pigments. An efficient, green synthesis of a compostable and widely applicable plastic (polylactic acid) made from corn.

Practical: **(60 Hours)**

Characterization by melting point, UV-Visible spectroscopy, IR spectroscopy and any other specific method should be done (wherever applicable).

1. Preparation and characterization of nanoparticles of gold using tea leaves/silver nanoparticles using plant extracts.

2. Preparation of biodiesel from waste cooking oil and characterization (TLC, pH, solubility, combustion test, density, viscosity, gel formation at low temperature and IR can be provided).
3. Benzoin condensation using thiamine hydrochloride as a catalyst instead of cyanide.
4. Extraction of D-limonene from orange peel using liquid CO_2 prepared from dry ice.
5. Mechanochemical solvent free, solid-solid synthesis of azomethine using *p*-toluidine and *o*-vanillin/*p*-vanillin.
6 Microwave-assisted Knoevenagel reaction using anisaldehyde, ethylcyanoacetate and ammonium formate.
7. Photoreduction of benzophenone to benzopinacol in the presence of sunlight.
8. Photochemical conversion of dimethyl maleate to dimethyl fumarate (*cis-trans* isomerisation)
9. Benzil- Benzilic acid rearrangement: Preparation of benzilic acid in solid state under solvent-free condition.

References:

Theory:

1. Anastas, P.T., Warner, J.C. (2014), **Green Chemistry, Theory and Practice**, Oxford University Press.
2. Lancaster, M. (2016), **Green Chemistry: An Introductory Text**, 3rd Edition, RSC Publishing.
3. Cann, M. C., Connely, M.E. (2000), **Real-World cases in Green Chemistry, American Chemical Society**, Washington.
4. Matlack, A.S. (2010), **Introduction to Green Chemistry**, 2nd Edition, Boca Raton: CRC Press/Taylor & Francis Group publisher.
5. Alhuwalia, V.K., Kidwai, M.R. (2005), **New Trends in Green chemistry**, Anamalaya Publishers.
6. Sidhwani, I.T, Sharma, R.K. (2020), **An Introductory Text on Green Chemistry**, Wiley India Pvt Ltd.

Practical:

1. Kirchoff, M.; Ryan, M.A. (2002), **Greener approaches to undergraduate chemistry experiment**, American Chemical Society, Washington DC.
2. Sharma, R.K.; Sidhwani, I.T.; Chaudhari, M.K. (2013), **Green Chemistry Experiments: A monograph**, I.K. International Publishing House Pvt Ltd. New Delhi.
3. Pavia, D.L.; Lamponam, G.H.; Kriz, G.S.W. B. (2012), **Introduction to organic Laboratory Technique- A Microscale approach**, 4th Edition, Brooks-Cole Laboratory Series for Organic chemistry.
4. Sidhwani I.T. (2015), Wealth from Waste: A green method to produce biodiesel from waste cooking oil and generation of useful products from waste further generated. **DU Journal of Undergraduate Research and Innovation**, 1(1),131-151. ISSN: 2395-2334.
5. Sidhwani, I.T; Sharma, R.K. (2020), **An Introductory Text on Green Chemistry**, Wiley India Pvt Ltd.

6. **Monograph on Green Chemistry Laboratory Experiments**, Green Chemistry Task Force Committee, Department of Science and Technology, Government of India.

Keywords: Green chemistry, Twelve principles of green chemistry, Atom economy, Waste minimization, green metric, green solvents, Solvent free, Catalyst, Bio-catalyst, Renewable energy sources, Hazardous, Renewable feedstock, Ionic liquids, Supercritical fluids, Inherent safer design, green synthesis, combinatorial, Sustainable development, Presidential green chemistry awards.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

BHASKARACHARYA COLLEGE OF APPLIED SCIENCE

Category I

B.Sc. (Honours) Polymer Science

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Chemistry and Engineering of Polymer Reactions (CEPR)	4	3	0	1	12th with PCM	--

Learning Objectives

- To learn about the different polymerizations
- To study kinetics of chain growth and step growth polymerization
- To understand general concepts, principles, kinetics and methodology of polymerization

Learning outcomes

The Learning Outcomes of this course are as follows:

- Know about overview of aspects of polymer engineering
- Understand essential fundamentals and chemistry of the polymerization processes.
- Learn about various terms such as reaction initiation, propagation and termination

SYLLABUS OF DSC-4

UNIT – I **06 Hours**

INTRODUCTION

Introduction to polymerization process, control of polymer synthesis; thermodynamic and kinetic control, diffusion control, polymer end chain control & control strategies, Introduction to reactor design, Interpretation of batch reactor data; design equations for ideal reactors, namely batch, CSTR, plug flow, design equation for single reaction systems using batch and semi batch, CSTR, PFR, Multiple reactor system; reactor in series and parallel, preference of type of reactor used

UNIT – II **09 Hours**

RADICAL CHAIN POLYMERIZATION

Introduction, thermodynamic and kinetic aspect of radical chain polymerization, rate of polymerization, kinetic chain length, Mayo's equation, cage efficiency, selection criteria of initiators, ceiling temperature, Tromsdorff effect, inhibition and retardation Ziegler-Natta catalyst and stereoregular polymerizations, Radical chain copolymerization (reactivity ratio, copolymer equations)

UNIT – III **06 Hours**

REDOX & OTHER INITIATIONS

Initiation in aqueous media, initiation in non-aqueous media, rate of redox polymerization, photochemical initiation, rate of photo-polymerization, initiation by ionizing radiation, electrolytic polymerization, plasma polymerization.

UNIT – IV **09 Hours**

IONIC CHAIN & CONTROLLED POLYMERIZATIONS

Classification of ionic species, effect of solvents, initiation, propagation and termination in ionic polymerization, cationic polymerization, anionic polymerization, introduction of Atom Transfer Radical Polymerization (ATRP), Reversible Addition-Fragmentation Chain Transfer Polymerization (RAFT) and Nitroxide mediated polymerization (NMP)

UNIT – V **09 Hours**

STEP GROWTH POLYMERIZATION

Reaction engineering of step growth polymerization: basic properties & examples of commercially important polymers, reactivity of functional groups kinetics of step polymerization, self-catalyzed & external catalysis of polymerization, molecular weight distribution in linear & nonlinear polymerization, effect of non-equivalence of functional groups, equilibrium considerations,

UNIT – VI **06 Hours**

POLYMERIZATION TECHNIQUES

Bulk, solution, precipitation, suspension & emulsion polymerization.

Practical - **30 Hours**

- To prepare polystyrene/poly(methyl methacrylate) by bulk polymerization and determine the rate of polymerization.
- To study the effect of reaction temperature on free radical polymerization of styrene/MMA.
- To study the effect on initiator concentration of free radical polymerization of styrene/MMA.
- Redox initiated polymerization of MMA & investigate the effect of viscosity on polymerization kinetics
- Redox polymerization of acrylamide
- To investigate Trommsdorff effect in bulk polymerization of MMA
- Solution polymerization of methyl methacrylate/styrene.
- Suspension polymerization of styrene/MMA.
- Emulsion polymerization of styrene/ methyl methacrylate.
- Preparation of Poly (vinyl butyral).

Essential/recommended readings

- Odian, G., (2004) Principles of Polymerization, Wiley-interscience.
- Billmeyer F.A., (2011) Textbook of Polymer Science, John-Wiley & Sons.
- Seymour R.B., Carraher C.E., (2003) Polymer Chemistry, Marcel Dekker.
- Flory P.J., (2007) Principles of Polymer Chemistry, Asian Books Private Limited.
- Levenspiel, O. (1998). Chemical reaction engineering. John Wiley & Sons.

Suggestive readings

- Brydson J.A., (2016) Plastics Materials, Butterworth Heinemann, 8th Edition.
- Lenz, R. W. (1967). Organic chemistry of synthetic high polymers.
- Gowarikar V.R., (2019) Polymer Science, New Age International Publishers Ltd, 3rd Edition

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 5: POLYMER RHEOLOGY (PR)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
POLYMER RHEOLOGY (PR)	4	3	0	1	12^{th} Pass	---

Learning Objectives

- To enhance fundamental knowledge of flow behaviour of polymer melts
- To understand the concept of mixing of polymers

Learning outcomes

The Learning Outcomes of this course are as follows:

- Apply the knowledge of measurement of viscosity in handling of rheological instruments
- Interpret rheology of polymer melts by mechanical models

SYLLABUS OF DSC- 5

UNIT – I **(12 Hours)**

RHEOLOGICAL PRINCIPLES

Viscosity and polymer processing, rheological properties of fluids, shear stress in polymers, Newtonian & non-Newtonian flow, polymer melt viscosities (ideal molten chains, microscopic studies of melts), flow in channels, simple shear flow, melt-flow index, Weissenberg effect, die swell, melt fracture, creep & creep compliance, stress relaxation, isochronous stress-strain curves

UNIT – II **(15 Hours)**

MELT FLOW ANALYSIS

Types of fluid & rheological models, rheological measurements by capillary, parallel plate and cone & plate viscometers, simple elongational flow and its significance, dynamic flow behavior, time dependent fluid behavior

UNIT – III **(09 Hours)**

RHEOLOGICAL MODELS

The elastic and viscoelastic state of polymers – viscoelasticity, viscoelastic models: Maxwell model, Voigt-Kelvin model, Boltzmann superposition principle, dynamic mechanical testing

UNIT – IV **(09 Hours)**

MIXING OF POLYMERS

Types of mixing, concept and importance of master batches, mixing of additives with the polymers, melt compounding

Practical - **30Hours**

- Determination of melt flow index of a polymer such as PP, PS, LDPE etc.
- Determination of intrinsic viscosity by Ubbelohde viscometer.
- Determination of rheological properties of polymer melts by rheometers.
- Measurement of resin/paint viscosity by Ford cup 4.
- Measurement of dynamic viscosity by Brookfield Viscometer.
- Compounding of polymers and investigation of their rheological behavior.
- Industry/R&D organization visit.

Essential/recommended readings

- Gupta B.R., (2004) Applied Rheology in Polymer Processing, Asian Books.
- Rosen S.L., (2012) Fundamental Principles of Polymeric Materials, Wiley-Interscience.
- Ghosh P., (2010) Polymer Science and Technology of Plastic and Rubber, Tata McGraw Hill.
- Aklonis J., Macknight W.J., (2005) Introduction to Polymer Viscoelasticity, John Wiley & Sons
- Middleman, S. (1968). Flow of high polymers; continuum and molecular rheology.

Suggestive readings

- Bird R.B., Armstrong R.C., Hassager O., (1977) Dynamics of Polymeric Liquids (volume 1), John Wiley & Sons, New York.
- Shaw M.T., (2012) Introduction to Polymer Rheology, John Wiley & Sons.
- Dealy, J. M., & Wissbrun, K. F. (2012). Melt rheology and its role in plastics processing: theory and applications. Springer Science & Business Media.
- Hiemenz, P. C., & Lodge, T. P. (2007). Polymer chemistry. CRC press.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 6: POLYMER TECHNOLOGY(PT)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
POLYMER TECHNOLOGY(PT)	4	3	0	1	12th Pass	-

Learning Objectives

- To learn about the production, properties and applications of thermoset and thermoplastic polymers
- To learn about the chemistry and manufacturing of flexible and rigid polyurethane foams
- To understand the modification of unsaturated polymers

Learning outcomes

The Learning Outcomes of this course are as follows:

- Learn preparation of thermoplastic polymers
- Learn preparation of thermosetting polymers
- Apply the knowledge of polymer synthesis to obtain polymers with desired properties

SYLLABUS OF DSC-6

UNIT – I **(27 Hours)**

THERMOPLASTIC POLYMERS

Manufacturing process, properties and applications of the following polymers:

- Polyethylene (LDPE,LLDPE,VLDPE, HDPE)
- Polypropylene and related copolymers
- Polystyrene ABS, HIPS and related copolymers
- Poly (vinyl chloride) and related copolymers
- Poly (vinyl acetate) and related polymers
- Acrylic polymers (PMMA,PEA, PAA, PAN, Polyacrylamide)
- Aliphatic polyamides (Nylon 6, Nylon 66, Nylon 6,10)
- Polyester (PET, PBT)

UNIT – II **(18 Hours)**

Manufacturing process, curing, properties, and applications of the following polymers:

- Unsaturated polyester resins

- Phenol formaldehyde resins (resols and novolacs)
- Urea and melamine formaldehyde resins
- Epoxides
- Polyurethanes (Flexible & Rigid foams)

Practical - 30 Hours

- Preparation of PMMA bone cement.
- Preparation and testing of epoxy resins
- Preparation of Nylon 6,10 by interfacial polymerization
- Preparation of phenolic resin for adhesive applications.
- Preparation of unsaturated polyester resin and determination of molecular weight by acid value/hydroxyl value.
- Synthesis of copolymer of styrene & maleic anhydride, and styrene & MMA and determination of reactivity ratios.
- To prepare melamine formaldehyde product viz. crockery etc.
- Synthesis of Polyurethane Foams
- Preparation of sodium polyacrylate salt and poly(acrylic acid) from polyacrylamide.

Essential/recommended readings

- Brydson J.A., (2016) Plastics Materials, Butterworth Heinemann, 8th Edition.
- Mittal Vikas, (2011) High Performance Polymers and Engineering Plastics, Wiley.
- Seymour R.B., Carraher C.E., (2003) Polymer Chemistry, Marcel Dekker.
- Billmeyer F.A., (2011) Textbook of Polymer Science, John-Wiley & Sons.
- Gowarikar V.R., (2019) Polymer Science, New Age International Publishers Ltd, 3rd Edition

Suggestive readings

- Flory P.J., (2007) Principles of Polymer Chemistry, Asian Books Private Limited.
- Mark J.E. Erman B., Eirich F.R., (2005) The Science and Technology of Rubber, Elsevier Academic Press.
- Sperling, L. H. (2005). Introduction to physical polymer science. John Wiley & Sons.
- Crompton R.T., (1989) Molecular Motions in High Polymers, Pergamon Press N.Y.
- Crompton T.R., (1989) Analysis of Polymers, Pergamon Press N.Y.
- Treloar, L. R. G. (1983). Mechanical Properties of Solid Polymers, IM Ward, John Wiley & Sons Ltd, Chichester.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

Category-IV

COMMON POOL OF GENERIC ELECTIVES (GE) COURSES OFFERED BY THE DEPARTMENTS

GENERIC ELECTIVES (GE-4): BIOMEDICAL APPLICATIONS OF POLYMERS(BAP)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
BIOMEDICAL APPLICATIONS OF POLYMERS (BAP)	4	2	0	2	12th Pass	---

Learning Objectives

- To acquire knowledge of biopolymer and biodegradation
- To gain knowledge of applications and testing of biopolymers

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand the basic concepts and requirement of biomaterials and biocompatibility
- Apply the knowledge of various biomaterials for a desired bio-application

SYLLABUS OF GE-4

UNIT – I **(06 Hours)**

BASICS OF BIOMATERIALS

Concept of biocompatibility and biodegradability, responsiveness, estimations of degradation and biocompatibility, Important biomaterials: hydrogel, fibres, bio-ceramics, bio-elastomers and membranes

UNIT – II **(04 Hours)**

POLYMERS AS BIOMATERIALS

Polyester and polysaccharides, natural gums, biodegradable polymers, polymers and hydrogels

UNIT – III **(10 Hours)**

BIOMATERIALS FOR ORGAN TRANSPLANTS AND TISSUE ENGINEERING

Properties and applications of polymers for organ transplant e.g. dental cement, orthopedic, skin, artificial kidney etc., basic concepts of tissue engineering, Important polymers for tissue engineering: cellulose, chitosan and alginates

UNIT – IV **(10 Hours)**

DRUG DELIVERY AND WOUND CARE

Introduction to drug delivery, polymers in controlled drug delivery, dressing strips, polymer drug vessels, core shell and nanogels, polymers for antimicrobial activity, bio-conjugates

Practical **- 60 Hours**

- Evaluate the biocompatibility of polymeric samples.
- Determination of the degradation behavior of polymers such as thermal, hydrolytic degradation etc.
- Preparation of membranes and measurement of absorption behavior.
- Preparation and characterization of dental cement.
- Preparation of a hydrogel and its characterization.
- Determination of tensile strength of biopolymers.
- Determine the swelling rate of biopolymers
- Preparation of nanogel and find its water absorption
- preparation and characterization of membrane for skin transplant

Essential/recommended readings

- Tiwari A., Tiwari A., (2013) Nanomaterials in drug delivery, Imaging and Tissue Engineering, Wiley.
- Pilla S., (2011) Handbook of Bioplastics and Biocomposites Engineering Applications, Wiley.
- Ratner, Buddy D., Allan S. Hoffman, Frederick J. Schoen, and Jack E. Lemons. "Biomaterials science: an introduction to materials in medicine." San Diego, California (2004): 162-4.
- Park, J. B., & Bronzino, J. D. (2002). Biomaterials: principles and applications. crc press.

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Suggestive readings

- Ratner D., Hoffman A.S., (1996) An Introduction to Materials in Medicine, Academic Press.
- Saltzman W.M., (2001) Drug delivery–Engineering principles for drug therapy, Oxford University Press.
- Kalia S., Averous L., (2011) Biopolymers: Biomedical and Environmental Applications, John Wiley & Sons.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVES (GE-5): POLYMERS FOR PACKAGING (PP)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
POLYMERS FOR PACKAGING (PP)	4	2	0	2	12th Pass	---

Learning Objectives

- To learn about the basic necessities and importance of packaging
- To acquire knowledge of various types of packaging materials

Learning outcomes

The Learning Outcomes of this course are as follows:

- Apprehend the basic concepts of packaging and its utilization for desired applications
- Assess the quality of packaging material and packaged product

SYLLABUS OF GE-5

UNIT – I **(06 Hours)**

PACKAGING SYSTEMS

Types of packaging systems: box, bottle, tetra, pouch, shrink, vacuum, gas, controlled atmosphere packaging (CAP), modified atmosphere packaging (MAP), and aseptic packaging

UNIT – II **(08 Hours)**

POLYMERS IN PACKAGING

Properties and applications: LLDPE, LDPE, HDPE, HMHDPE, PP, PVC, nylons, polyester, polycarbonate, PS, EPS, PLA, PVA and Starch

UNIT – III **(08 Hours)**

PACKAGING PROCESS TECHNIQUES

Preparation of packaging materials by thermoforming, co-extrusion, extrusion-stretch blow molding, injection molding, BOPP films

UNIT – IV **(08 Hours)**

TESTING OF POLYMER PACKAGING MATERIAL

Bursting strength, tensile strength, tear strength, puncture test, impact test (Drop, falling dart), permeability test (water vapour, oxygen), biodegradability, sealing strength

Practical - 60 Hours

- To identify packaging materials with the help of FT-IR, DSC, TGA etc.
- Determination of physico-mechanical properties (density, burst strength, tensile strength, tear strength, puncture test strength, impact strength etc).
- Determination of water vapor transmission rate of packaging material.
- To test sealing strength integrity of packaging materials.
- To check biodegradability of packaging material.
- Preparation biodegradable packaging film
- Determination of water vapor transmission rate of packaging material.
- To test seal strength integrity of packaging materials.
- To check biodegradability of packaging material.
- To determine compatibility of film.

Essential/recommended readings

- Robertson G.L., (2005) Food Packaging Principles and Practice, CRC press.
- Paine F.A. and Paine H.Y., (1992) A Handbook of Food Packaging, Blackie Academic and Professional.
- Sharma S., Aggarwal M., Sharma D., (2019), Food Frontiers, New Delhi Publisher
- N. C. Saha, M. Garg, S. Dey Sadhu, A. K. Ghosh(2022) Food Packaging-Materials, Techniques and Environmental Issues" by published by Springer.
- Garg, M., Meena, P.L., Sadhu, S.D., Alam, T. (2019). Food Packaging: A Practical Guide : Viba Press Pvt. Ltd.

Suggestive readings

- Robertson G.L., (2012) Food Packaging–Principles and Practice, CRC Press.
- Coles R, McDowell D., Kirwan M.J., (2003) Food Packaging Technology, Blackwell.
- Sukhareva L.A., Yakolev V.S., Legonkova O.A., (2008) Polymers for packaging materials for preservation of foodstuffs, VSP.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVES (GE-6): POLYMERS FOR ELECTRICAL AND ELECTRONIC APPLICATIONS (PEEA)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
POLYMERS FOR ELECTRICAL AND ELECTRONIC APPLICATIONS (PEEA)	4	2	0	2	12th Pass	----

Learning Objectives

- To learn about basic concepts of polymer electrical and electronic properties
- To gain knowledge of electrical and electronics applications of polymers

Learning outcomes

The Learning Outcomes of this course are as follows:

- Synthesize a conducting polymer for a specific application
- Apply the knowledge of properties of polymers required for electrical and electronics applications

SYLLABUS OF GE-6

UNIT – I **(08 Hours)**

INTRODUCTION TO POLYMERS

Petro polymers, conducting polymers, biopolymers, composites, Band diagram, processing of polymers, doping (chemical and ion), advantages and disadvantages of conducting polymers, limitations

UNIT – II **(08 Hours)**

PREPARATION OF CONDUCTING POLYMERS

Synthetic methods: chemical, electrochemical, photochemical etc. (polyaniline, polypyrrole, polythiophene, polyacetylene, etc.), methods to enhance the processability of conducting polymers

UNIT – III **(08 Hours)**

PROPERTIES

Dielectric strength, dielectric loss, charge storage capacity, electrical conductivity, heat capacity, magnetism, hysteresis loop, shape memory, mechanical properties, EMI shielding

UNIT – III **(06 Hours)**

ELECTRONIC APPLICATIONS

Semiconducting organic materials, polymer based electronic devices, organic field effect transistor, organic transistors, plastic solar cell, light emitting diode, supercapacitor, sensors etc.

Practical - **60 Hours**

- Preparation of conducting polyaniline and measurement of their conductivity.
- Preparation of polypyrrole and measurement of their conductivity.
- Preparation of polythiophene and measurement of their surface resistivity.
- Preparation and testing of conducting polymers for sensor applications.
- Measurement of multilayer insulation of a thin film.
- Measurement of dielectric strength of a polymer film.
- Measurement of mechanical properties of insulating cable
- Preparation polymer sample and analyzed its dielectric strength
- Preparation of a conducting polymer nanocomposites.
- Preparation polymeric semiconductor

Essential/recommended readings

- Skotheim T.A., Elsenbaumer R.L., Reynolds J.R., (1998) Handbook of conducting polymers, Vol. 1 and Vol. 2, Marcel Dekker.
- Nalwa H.S., (1977) Organic Conductive Molecules and Polymers, John Wiley & Sons.
- Bredas J.L., Silbey R., (1991) Conjugated Polymers: The Novel Science and Technology of Highly Conducting and Nonlinear Optically Active Materials, Kluwer Academic Publishers.
- Bikales M., Menges O.B., (1986) Encyclopedia of Polymer science and Engineering, Second Edition, Vol.5, John Wiley & Sons.

Suggestive readings

- Lyons M.E.O., (1994) Electroactive polymers, Plenum Press.
- Margolis J., (1993) Conducting Polymers and Plastics, Chapman & Hall.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DEPARTMENT OF ANTHROPOLOGY

Category-I
BSc. (Hons.) Environmental Science

DISCIPLINE SPECIFIC CORE COURSE -4 (DSC-4) – : Human Origins and Evolution

Credit distribution, eligibility and pre-requisites of the course:

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Human Origins and Evolution	4	3	0	1	12th Pass	----

Learning Objectives

1. The course will enhance students understanding of human variation in the light of human origins.
2. The course will help students to develop concepts pertaining to the relation of modern humans with living and non-living primates.

Learning Outcomes

Students will learn on evolutionary relationships of different extinct/hominids in the context of emergence of modern human beings. Students will also learn the gradual biological and behavioral processes of becoming human.

Syllabus:

Unit-1 **(12 Hours)**

Primate origins and radiation: phylogenetic relationships of living primates with special reference to Miocene hominoids

Unit-2 **(12 Hours)**

Australopithecines: distribution, features and their phylogenetic relationships. Appearance of genus Homo: Homo habilis

Homo erectus from Asia, Europe and Africa: Distribution, features and their phylogenetic status

Unit-3 **(12 Hours)**

The origin of Homo sapiens: Fossil evidences of Neanderthals.

Origin of modern humans (Homo sapiens sapiens): Archaic and Modern humans, Distribution and features

Unit-4 **(9 Hours)**
Hominization process: Bio-cultural Evolution

Practical – **30 Hours**

Craniometry:

a) Maximum Cranial Length
b) Maximum Cranial Breadth
c) Maximum Bizygomatic Breadth
d) Maximum Frontal Breadth
e) Minimum (Least) Frontal Breadth
f) Nasal Height
g) Nasal Breadth
h) Bi-Mastoid Breadth
i) Greatest Occipital Breadth
j) Upper Facial Height
k) Cranial Index
l) Nasal Index

Osteometry: Measurements of Human long bones (6)

Identification of casts of fossils of family hominidae: Drawing and comparison of cranial characteristics.

References

1. Indera P. Singh and Bhasin, M.K. (1968) Anthropometry. Kamla-Raj Enterprises, Chawri Bazar, Delhi.
2. Buettner-Janusch, J. (1966). Origins of Man: Physical Anthropology. John Wiley & Sons, Inc., New York, London, Sydney.
3. Craig Stanford et al. (2013). Biological Anthropology. Pearson, New York. [Unit-1: Page-261-300; Unit-2: Page-324-335; Unit-3: Page-342-375; Unit-4: Page-382-412; Unit-5 and 6: Page-418-441]
4. Nystrom P. and Ashmore P. (2011). The Life of Primates. PHI Learning Private Limited, New Delhi.
5. Seth P. K. and Seth S. (1986). The Primates. Northern Book Centre, New Delhi, Allahabad.
6. Singh I. P. and Bhasin M.K. (1989). Anthropometry: A Laboratory Manual on Biological Anthropology.
7. Stanford C.; Allen J.S. and Anton S.C. (2012). Biological Anthropology: The Natural History of Mankind.
8. Swindler D. R. (2009). Introduction to the Primates. Overseas Press India Pvt. Ltd., New

Keywords

Human origin, Primates, Australopithecine, Homo erectus and evolution

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE -5 (DSC-5) – : Fieldwork Traditions and Ethnography

Credit distribution, eligibility and pre-requisites of the course:

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Fieldwork Traditions and Ethnography	4	3	0	1	12^{th} Pass	----

Learning Objectives:

- How ethnographers conceptualize, conduct, and analyse their research;
- The types of research practices for generating data
- The ethics of ethnographic research, in relationship to disciplinary history

Learning Outcomes:

- Ability to conduct ethnographic research
- Generate data and write field notes
- Analyse and interpret ethnographic data

Syllabus:

Unit 1 Fieldwork Tradition (12 Hours)

The emergence of fieldwork tradition in Anthropology; Ethnography, its Nature, Trajectories, Genres; Ethnography: Process and Product

Unit 2 Idea of Field (12 Hours)

Concept of field: Idea of Place and Space, and its changing contours, Multi-sited Ethnography and Virtual Spaces.

Unit 3 Doing ethnography (12 Hours)

Doing ethnographic Fieldwork: Fieldwork Identity; Rapport and Relations; Representation and Emotions; Ethical issues.

Unit 4 Field Methods and Writing (09 Hours)

Observation, Interview, Case Study, Life History, Genealogy, Sensory Ethnography, Reflexivity and Ethnographic Writing

Practical – 30 Hours

Designing Ethnographic Research: Identifying a problem, Defining the universe, Literature Review, selecting appropriate methods; doing Fieldwork: field diaries and field notes; Analysis and Writings.

1. Students are required to visit different field sites and come up with observational and experiential learnings
2. Presentations based on a Research Project

References

1. Clifford, J., & Marcus, G. E. (2011). *Writing culture: The poetics and politics of ethnography*. Berkeley, California: University of California Press.
2. O'Reilly, K. (2009). *Key Concepts in Ethnography (SAGE key concepts)*. Sage Publications.
3. Narayan, K. (2012). *Alive in the writing: Crafting ethnography in the company of Chekhov*. Chicago: University of Chicago Press.
4. Robben, C.G.M. and Jeffrey A. Sluka. (2012). Ethnographic Fieldwork: An Anthropological Reader. Oxford: Wiley-Blackwell.
5. Srinivasa, M. N., Shah, A. M., & Ramaswamy, E. A. (2008). *The fieldworker and the field*. New Delhi: Oxford University Press.
6. Srivastava, V. K. (2005). *Methodology and fieldwork*. New Delhi: Oxford University Press.

Keywords: Fieldwork, Ethnography, Ethics, Writing, Reflexivity

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE -6 (DSC-6) – : Human ecology and biological adaptation

Credit distribution, eligibility and pre-requisites of the course:

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Human ecology and biological adaptation	4	3	0	1	12th Pass	----

Learning Objectives

1. To introduce human ecology through biological perspectives where impetus will be laid on building a sense of awareness, empathy and understanding of existing environmental problems at various subsistence levels.
2. The course focuses on environmental matters that need attention on imperative basis.

Learning Outcomes

1. The students will be trained to identify biological adaptation strategies that can throw light on the resilient measures in different environmental stresses.
2. The students can be better equipped to understand the impact of various environments on everyday human life and can critically reflect on adoption of a healthy and sustainable environment.
3. The students can be encouraged to come up with innovative strategies to reduce the environmental menace created by humankind and aim towards a sustainable future.

Syllabus:

Unit I: Fundamentals of Human ecology **(12 Hours)**

- Human ecology and its interdisciplinary approaches
- Complexity and diversity of human population with respect to environment
- Concepts of human ecology and adaptation with special emphasis on biological dimensions

Unit II: Tools to understand human ecology **(12 Hours)**

- Methods of studying human ecology
- Indigenous knowledge for sustainability in various environments

Unit III: Human adaptation: Population and environment **(12 Hours)**

- Adaptation to various ecological stresses
- Ecological rules and their applicability to human populations

Unit IV: Human health and environment (09 Hours)

- Impact of various environments on human health
- Impact of urbanization and industrialization on humans

Practical – 30 Hours

A. *Size and Shape Measurements*:

1. Stature
2. Sitting Height
3. Body Weight
4. Total Upper Extremity Length
5. Total Lower Extremity Length
6. Nasal Breadth
7. Nasal Height

B. *Size and Shape Indices:*

1. Body Mass Index
2. Relative Sitting Height
3. Relative Upper Extremity Length
4. Relative Total Lower Extremity Length
5. Nasal Index

C. 1-2 public talks/workshops/project over the academic semester on research topics on human ecology and biological adaptation. These talks would bring students with brainstorming discussion on current issues.

References

1. H. Schutkowski. (2006) Human Ecology: Biocultural adaptations in Human communities, Springer Verlag, Germany (Unit 1).
2. Wilk. Richard and Haenn Nora (2006). The environment in Anthropology. New York University Press. NY. (Unit 2).
3. Ember and Ember (2014) Anthropology, Pearson publication, Hudson Avenue, New Jersey. (Unit 3)
4. Wilk. Richard and Haenn Nora (2006): The environment in Anthropology. New York University Press. NY. (Unit 4)

Teaching Learning Process

1. Classroom teachings
2. Seminars and presentations
3. Practical classes
4. Workshop

Keywords: adaptation, human ecology, ecological stresses, health

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

CATEGORY-IV

COMMON POOL OF GENERIC ELECTIVES (GE) COURSES OFFERED BY DEPARTMENT OF ANTHROPOLOGY

Credit distribution, Eligibility and Pre-requisites of the Course

GENERIC ELECTIVES (GE-7): Physical fitness, Activity and Performance

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Physical fitness, Activity and Performance	4	3	0	1	12th Pass	---

Learning Objectives:

The course is structured around the relevance of being physically fit in today's environment. It will further focus on increasing one's performance and activity through anthropological knowledge.

Learning Outcomes:

1. The students will learn about various components of health-related and skill related physical fitness.
2. The students will learn about the importance of physical fitness in performing and sustaining daily activities.
3. They will also learn about the relevance of physical fitness and performance in sports science and how it helps in designing the most appropriate athletic training program.
4. They will learn how anthropological knowledge is of immense importance in fitness and performance.

Syllabus

Unit I: Introduction to physical fitness and performance (12 Hours)

Definition, scope, and relevance of physical fitness and performance, ways to improve physical fitness and performance, various types of physical fitness and performance test

Unit II: Measure of physical fitness and performance (12 Hours)

Cardiovascular endurance, Muscular strength, Muscular endurance, Flexibility, Body composition, skill related components of physical fitness

Unit III: Physical fitness and performance in sports and health science (12 Hours)

Importance of physical fitness and performance in preventing chronic and lifestyle disease, talent identification in sport science by determining an athlete's strengths and weaknesses, doping and performance.

Unit IV: Anthropological knowledge in physical fitness and performance (09 Hours)

Relevance of anthropology in studying physical fitness, activity and performance, understanding physical fitness and performance by taking into consideration the ethnic and racial differences

Practical – 30 Hours

1. Physical fitness and performance test
2. **Physiological Measurements**- Blood pressure, Heart rate, Pulse rate
3. **Somatometric Measurements-** Height, weight, skinfolds, hip circumference, waist circumference, mid-upper arm circumference, neck circumference, calf circumference, thigh circumference

1-2 workshops/projects over the academic semester on topics related to anthropology. It would bring students to brainstorming discussions on current issues and help them develop innovative ideas.

References:

1. Physical working capacity and physical fitness; relationship of body measurements with cardio-vascular and respiratory functions- Physical Activity and Health by C. Bouchard, S.N Blair,W.L Haskell Chapter 3(Page 37-42)
2. Irurtia, Alfredo, Víctor M. Torres-Mestre, Álex Cebrián-Ponce, Marta Carrasco-Marginet, Albert Altarriba-Bartés, Marc Vives-Usón, Francesc Cos, and Jorge Castizo-Olier. "Physical Fitness and Performance in Talented & Untalented Young Chinese Soccer Players." In *Healthcare*, vol. 10, no. 1, p. 98. MDPI, 2022.
3. Vaara, Jani P., Heikki Kyröläinen, Jaakko Niemi, Olli Ohrankämmen, Arja Häkkinen, Sheila Kocay, and Keijo Häkkinen. "Associations of maximal strength and muscular endurance test scores with cardiorespiratory fitness and body composition." *The Journal of Strength & Conditioning Research* 26, no. 8 (2012): 2078-2086.
4. Pate, Russell, Maria Oria, and Laura Pillsbury. "Health-related fitness measures for youth: flexibility." In *Fitness Measures and Health Outcomes in Youth*. National Academies Press (US), 2012.
5. Chen, W., Hammond-Bennett, A., Hypnar, A., & Mason, S. (2018). Health-related physical fitness and physical activity in elementary school students. *BMC public health*, *18*(1), 195. https://doi.org/10.1186/s12889-018-5107-4

6. Donnelly, J. E., Hillman, C. H., Castelli, D., Etnier, J. L., Lee, S., Tomporowski, P., Lambourne, K., Szabo-Reed, A. N., & This summary was written for the American College of Sports Medicine by (2016). Physical Activity, Fitness, Cognitive Function, and Academic Achievement in Children: A Systematic Review. *Medicine and science in sports and exercise*, *48*(6), 1223–1224. https://doi.org/10.1249/MSS.0000000000000966
7. Eston, R. and Reilly, T. (2009).KINANTHROPOMETRY AND EXERCISE PHYSIOLOGY LABORATORY MANUAL Volume One: Anthropometry. Tests, procedures and data. Routledge.

Teaching Learning Process

- Classroom teachings
- Seminars and Interactive sessions
- Practical classes/ Field work

Keywords: Physical fitness, performance, health science

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVES (GE-8): CUSTOMARY LAW

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Customary Law	4	3	0	1	12th Pass	---

Learning objectives:

The course is designed to help students understand the approaches to the study of different types of law, particularly customary law. It will also help students to learn the contradictions, inconsistencies inherent in the interface between customary law and the state law.

Learning Outcomes: On completion of the course, students will be able to:

- Locate nuances of diverse customs from around the world based on ethnographic works.
- Make critical evaluation of gendered laws which are intricately enmeshed within the social fabric.
- Gain insights into the workings of state agency that blurs the boundary of customary law and the state.

Syllabus:

Unit 1: Understanding Customary Law **(12 Hours)**

Customary Law: Concepts and Approaches; Types of Customary Law: Restitutive, Repressive; Anthropological literature: Bronislaw Malinowski, Evans-Pritchard, Meyer Fortes, Max Gluckman, Leopold Pospisil

Unit 2: Custom, Crime and Justice **(12 Hours)**

Law and Justice in simple societies; Classification of Crimes among indigenous communities; Oath taking and Ordeal; modes of dispute settlement

Unit 3: Gender and Customary Law **(12 Hours)**

Gendered laws, Inheritance, Succession, Custody of Children and Properties, Political Representation

Unit 4: Customary Law and the State Law **(09 Hours)**

Interface between customary law and state law; Codification of customary law and its implications

Practical – **30 Hours**

- Review of ethnographic works and find out: (i) types of crime, (ii) modes of dispute settlement, (iii) rationale behind ordeals/oaths.
- Project report on (i) customary law and the state law interface, or (ii) Cultural context of a dispute and search for its settlement in one or other legal domains.

References:

1. Evans-Pritchard, E. E and Meyer Fortes. 1940. *African Political Systems*. London: Oxford University Press.
2. Gluckman, Max. 1956. *Custom and Conflict in Africa*. Basil Blackwell Ltd.
3. Malinowski, B. 1926. *Crime and Custom in Savage Society*. London: Routledge & Kegan Paul Ltd.
4. Pospisil, Leopold. 1971. *Anthropology of Law: A comparative theory*. New York: Harper and Row Publishers.
5. Srivastava, Vinay Kumar. 2021. *India's Tribes: Unfolding Realities.* New Delhi: Sage Publications Indian Pvt. Ltd.
6. Zhimo, A.G. 2019. 'Indigenous system of Governance and its implication: The case of Sumi Naga. *Indian Anthropologist.* 49 (2): 41-56.

Keywords:

Customary law, oath taking, custom, dispute, state law

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVES (GE-9): Ethics and Legality in Human Research

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Ethics and Legality in Human Research	4	3	0	1	12th Pass	---

Learning Objectives

1. To understand bio-social ethical aspects of human research
2. To understand aspects of health research from ethical and legal perspectives

Learning Outcomes

The students will learn the basic understanding of ethics in different types of human research and learn the skills to assess ethical dimensions of research works based on human populations

Syllabus:

Unit 1: Introduction to the ethical dimensions of human research; history of ethics in human research; Ethical vs legal regulations **(12 Hours)**

Unit 2: Research Disclosure; Importance of Truth telling; Participant Information sheet; Participant's Capacity to understand human research, Voluntariness and Consent, **(12 Hours)**

Unit 3: Human rights; Confidentiality of participant's information; Risks and benefits, Vulnerability, research integrity **(12 Hours)**

Unit 4: Ethical guidelines of Indian Council of medical Research; Regulatory framework **(9 Hours)**

Practical: (30 Hours)

Report of ethical assessment based on research work related to human research.

References

Macklin R. Ethics in global health: research, policy, and practice [1 ed.]. Oxford University Press, 2012

Stephen Garrard Post Encyclopedia of bioethics [Volume 3, 3rd ed]. Macmillan Reference USA, 2004

Alastair V. Campbell. Bioethics: The Basics [1 ed.]. Routledge, 2013

Keywords

Ethics, human, participants, consent, confidentiality

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVES (GE-10): Quality of life and well-being

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Quality of life and well-being	4	3	0	1	12th Pass	----

Learning Objectives:

- To understand the concept of QoL and well-being.
- To learn about various domains and indicators related to QoL and well-being.
- To know the measures of QoL and well-being as per different community or geographical setting.
- To identify the similarity and differences in these two concepts.
- To understand the change in QoL and well-being as per disease severity and duration of symptoms in different age group and gender.

Learning outcomes:

- Learner will be able to understand the basic concept of QoL and well-being.
- Information about measures of well-being and QoL will be instilled.
- Learners will get to know about indicators and theoretical models of well-being and QoL
- Knowledge about evaluation of chronic illness treatment through wellbeing and HRQoL will be imparted.

Syllabus:

Unit 1: Fundamentals of quality of life and well being (12 Hours)

Concept of Quality of life (QoL), subjectivity and multidimensionality models, standard of living, life satisfaction, philosophical foundation, definitions and measures of QoL and well being

Unit 2: QoL and Chronic illness (12 Hours)

Quality of life as an evaluation tool for the treatment (HRQoL), functioning domains under QoL: physical, mental, emotional, intellectual, spiritual, and social functioning, impact of Covid-19 on QoL and well-being

Unit 3: Theories and indicators of QoL and well-being (12 Hours)

Hedonic and Eudaimonic well- being, objective, subjective and relational well-being, integrative theories of subjective QoL. Effect of technology, economic, political, socio-cultural, resource, domain dynamics on QoL and well-being.

Unit 4: Types of well-being **(09 Hours)**

Work, residential, material, social, family, marital, health, leisure. quality of life and well-being of Women, older adults, children, youth, geographic population segments etc.

Practical: **(30 Hours)**

To assess QoL and wellbeing of different population at different age groups.

1-2 workshops/projects over the academic semester on topics related to quality of life and wellbeing in anthropology. It would bring students to brainstorming discussions on current issues and help them develop innovative ideas.

References:

1. An Interdisciplinary Perspective edited by Shruti Tripathi, Rashmi Rai, Ingrid Van Rompay-Bartels, 1st edition, 2021, CRC press, Boca Raton https://doi.org/10.1201/9781003009139
2. https://www.springer.com/series/8365
3. Handbook of Active Ageing and Quality of Life,2021, ISBN: 978-3-030-58030-8
4. Well-Being as a Multidimensional Concept: Understanding Connections among Culture, Community, and Health, 2019, EDITED BY JANET M. PAGE-REEVES
5. Upton, D., Upton, P. (2015). Quality of Life and Well-Being. In: Psychology of Wounds and Wound Care in Clinical Practice. Springer, Cham. https://doi.org/10.1007/978-3-319-09653-7_4
6. https://www.cdc.gov/hrqol/wellbeing.htm

Teaching Learning Process

1. Classroom teachings
2. Seminars and Interactive sessions
3. Practical classes/ Field work

Keywords: Quality of life, wellbeing, Hedonic, Eudaimonic

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVES (GE-11): Tribes of India

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Tribes of India	4	3	0	1	12th Pass	---

Learning Objectives: The course is designed to help students understand the contested and problematic nature of the term 'tribe' and its definitional attributes. It also seeks to elucidate pressing issues faced by the tribes in India by focus on the contemporary issues, challenges and crisis that confront the rural and tribal communities in India.

Learning outcomes: At the end of the course, the student will be able to**:**

1. Comprehend the problematic nature of the concepts of tribe and indigenous; how it differs from caste.
2. Understand critical issues, problems and challenges related to tribal societies both in historical and contemporary perspectives.
3. Evaluate, plan and implement any project work in rural and tribal areas and be able to suggest remedial measures for critical issues.

Syllabus:

Unit 1: On the concept of tribe (12 Hours)

Concept and approaches to the study of tribes; classification, distribution and cosmogeny of tribes in India; Scheduled Tribe and Indigenous people; Particularly Vulnerable tribal groups

Unit 2: Tribes and institution (12 Hours)

Tribal kinship system, types of family, rules of marriage, tribal polity and governance, subsistence economy and tribal market, tribal religion: nature-man-spirit complex, witchcraft

Unit 3: Tribes, Development, and Globalization: (12 Hours)

Impact of development schemes on tribal societies; Displacement caused by large infrastructure projects; Globalization and the shift from isolation to integration.

Unit 4: Tribes and Policy (09 Hours)

National Tribal Policy; Forest Rights, Food security, land acquisition, mining, tribal migrants

Practical – **30 Hours**

Practical would involve examination of material culture including technologies used by the hunter and gatherers, horticulturalist pastoral and agriculture communities. Functional analysis of traps for fishing, hunting, digging stick, sickle and different types of knives and other equipment used for hunting. Different types of house forms, dress patterns etc. and their ecological adaptation in different climatic zones will also be required to studied functionally as well structural point of view. Student would also prepare a project report based upon empirical data collected on tribal issues

References:

Bailey, F.G. 1960. Tribes, caste and Nations: A study of political activity and political change inttighland Orissa.

Béteille, André. 1998. The Idea of Indigenous People. Current Anthropology, Vol. 39, No. 2 (April 1998), pp. 187-192.

Bhandari, J. S., and Subhadra Channa. 1997. Tribes and government policies. New Delhi: Cosmo Publications

Channa, Subhadra Mitra. 2020. Anthropological Perspectives on Indian Tribes. New Delhi: Orient Blackswan Private Limited

Chaudhury, Sukant K., and Patnaik, Soumendra Mohan. 2008. Indian Tribes and the `Mainstream. New Delhi. Rawat Publisher

Fürer-Haimendorf, Christoph von. 1985. Tribal populations and cultures of the Indian subcontinent. Handbuch der Orientalistik, Bd. Leiden: E.J. Brill.

Miri, Mrinal. 2003. Identity and the moral life. New Delhi: Oxford University Press.

Vidyarthi, L.P. 1977. Tribal Culture of India: concept publishing company.

Xaxa, Virginius. 2008. State, society, and tribes: issues in post-colonial India. New Delhi: Dorling Kindersley (India)

Teaching Learning Process

Lectures and Discussions

Seminars and Presentations

Keywords: Scheduled Tribe, Caste, Tribal Development, Tribal Policy, Indigenous People

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVES (GE-12): Environment and Health

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Environment and Health	**4**	**3**	**0**	**1**	**12th Pass**	**----**

Learning Objectives

1. To understand basic concepts of environmental health
2. To assess environmental pollutant classes
3. To assess the risk of environmental exposures and health impacts

Learning Outcomes
The students will learn the basic concepts of environmental and health, various exposures and pollutant classes, burden of disease and health impacts of ecological exposures

Syllabus:

Unit 1: Introduction to environment health. Epidemiological studies related to environmental health **(12 Hours)**

Unit 2: Water, Sanitation and Hygiene; impact of air pollution (ambient and indoor), water pollution and noise pollution on human health **(12 Hours)**

Unit 3: Human health under different socio-cultural environment, Built environment, Urban environment, Green spaces and occupational hazards, hygiene and health **(12 Hours)**

Unit 4: Food safety, toxins and waste management, chemicals and heavy metals **(09 Hours)**

Practical: **30 Hours**
Project report based on data collection related to environmental health

References

1. Hermen Koren. Handbook of environmental health and safety [volume_II, 4th ed.]. CRC Press, 2002
2. Morton Lippmann. Environmental toxicants: human exposures and their health effects [3rd ed]. John Wiley &Sons, 2009
3. B. Wisner J. Adams. Environmental Health in Emergencies and Disasters [1 ed.]. World Health Organization, 2003
4. Bernard J. Healey, Kenneth T. Walker. Introduction to Occupational Health in Public Health Practice (Public Health Environmental Health) [1 ed.]. Jossey-Bass;2009

Teaching Learning Process
The process of learning will involve acquisition of domain knowledge and understanding of skills required for conducting research in environmental health. Process will involve lectures and presentations and report submission.

Keywords
Pollutants, Environment, Exposure, Assessment, Water and Air pollution, social environment.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

<u>Category I</u>

BSc. (Honours) Biological Science
(Sri Venkateswara College)

DISCIPLINE SPECIFIC CORE COURSE – 4:

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Cell Biology (BS-DSC-201)	**4**	**2**	**0**	**2**	Class XII pass with Biology and chemistry, as one of the papers in Class XII	**NIL**

Learning Objectives

The Learning Objectives of this course are as follows:

- To introduce the students to the basic concepts and processes in cyto-biology.
- To understand the structure and function of cell organelles, how they communicate with each other and how division and regulation takes place in cells.
- The practical content of this course is designed to understand the cell measurement methods, cell division, staining procedure and tonicity through different laboratory exercises.

Learning outcomes

On successful completion of course, the student will:

- Understand the cell and its biology which will help them to get an insight into theorigin of cells, cellular structure, various components of cells and functions.
- Understand the chemical composition, physicochemical and functional organization oforganelle.
- Demonstrate the knowledge of common and advanced laboratory practices in cyto-biology.
- Acquire knowledge about how cells divide by means of meiosis and mitosis and willbe able to correlate different factors which control cell cycle progression.

SYLLABUS OF DSC-1

UNIT – I Overview of Cell and Cell membrane (07 Hours)

History of cell biology, cell theory, Structure and functions of membrane, models of membrane structure, transport across membranes (with examples): simple diffusion, facilitated diffusion, active transport (Na+/K+ pumps, Co-transport, proton pumps) and passive transport. Phagocytosis, pinocytosis, exocytosis.

UNIT – II Cell Organelles (13 Hours)

Mitochondria, chloroplast and nucleus: Ultrastructural organization and functions, marker enzymes, transport mechanisms in mitochondria and chloroplasts (Tim/Tom; Tic/Toc); and transport via nuclear pore complex.
Endomembrane system: Ultrastructural organization and functions of Rough and smooth endoplasmic reticulum, Golgi apparatus and lysosomes (GERL complex), tonoplast.
Glyoxysomes and Peroxisomes: Structure and function.

UNIT – III Cytoskeletal System (03 Hours)

Structure and organization of microfilaments, intermediate filaments, microtubules, their functions in plants and animals (in brief).

UNIT – IV Cell wall and extracellular matrix (04 Hours)

Cell wall organization (Primary and secondary cell wall), components of cell wall, Extracellular Matrix and Cell junctions, adhesive junctions, gap junctions and tight junctions, plasmodesmata. Function of cell wall.

UNIT – V Cell Division (03 Hours)

Overview of cell cycle. Regulation: Various checkpoints and the role of cyclins andCdks (Cyclin dependent kinases). Overview of mitosis and meiosis and theirsignificance

Practical component – 60 Hours

1. Estimation of cell size by micrometry/ camera lucida
2. To study plasmolysis and deplasmolysis in a cell/ Isolation of protoplast from tomato and its survival in hypo, hyper and isotonic solution
3. Study the effect of organic solvent/temperature on membrane permeability.
4. Demonstrate the phenomenon of protoplasmic streaming.
5. Study of ultrastructure of a cell (Plasma membrane, Nucleus, Nuclear Pore Complex, Chloroplast, Mitochondrion, Golgi bodies, Endoplasmic reticulum, Lysosomes) through electron micrographs.

6. Study of cytoskeletal structures through photographs.
7. Study of different stages of mitosis by temporary preparation of onion root tips.
8. Study of different stages of meiosis by temporary preparation /permanent slides.
9. Staining and visualisation of mitochondria by Janus green stain

Essential/recommended readings

1. Becker, W. M., Kleinsmith, L. J., Bertni, G. P. (2009). *The World of the Cell* (7thEd.). Pearson Benjamin Cummings Publishing, San Fransisco.
2. Cooper, G.M. and Hausman, R.E., (2009). *The Cell: A Molecular Approach*.(7thed.). ASM Press & Sunderland (Washington DC), Sinauer Associates, MA.
3. Karp, G., (2010). *Cell and Molecular Biology: Concepts and Experiments* (8thed.). John Wiley & SonsA Guidebook to mechanism in organic chemistry (2003) 6 th ed., Sykes, P. NewYork: John Wiley & Sons. Inc

Suggested readings

1. EDP De Robertis, and RE De Robertis (2009). *Cell and Molecular Biology* (8th Ed.).Lippincott Williams and Wilkins, Philadelphia.
2. Nelson, D.L. and Cox, M.M. (2017). *Lehninger: Principles of Biochemistry* (7thed.).
W.H. Freeman & Company (New York).

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 5

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Diversity of Life Forms-II (BS-DSC-202)	**4**	**2**	**0**	**2**	Class XII pass with Biology and chemistry, as one of the papers in Class XII	**NIL**

Learning Objectives

The Learning Objectives of this course are as follows:

- Designed with an aim to provide scope and historical background of evolution and diversity in plants and animals.
- impart knowledge regarding basic concepts of origin of chordates and make the students understand the characteristics and classification of animals with notochord.
- Outline various mechanisms involved in thriving/survival of the animals within their geographic realms.
- Understand important aspects of Gymnosperm classification, structure and economic importance.
- Provide an adequate exposure to fundamentals of plant systematics and most practiced classification systems.
- Emphasis will be on developing interest and invoking a sense of responsibility among students toward sustenance of plant and animal biodiversity.

Learning outcomes

Upon completion of the course, the students will be able to:

- Understand different characteristic features of different plant and animal life forms, classes of chordates, level of organization and evolutionary relationship between differentsubphyla and classes, within and outside the phylum.
- Study about diversity in animals and plants making students understand about theirdistinguishing features.
- Appreciate similarities and differences in life functions among various groups of animals and plants.
- Know about the habit and habitat of animals in marine, freshwater and terrestrial ecosystems.
- Understanding of systematics its importance in biodiversity management, nomenclature and classification systems of the plants.

SYLLABUS OF DSC- 2

UNIT – I Gymnosperms (04 Hours)

Position of Gymnosperms in five kingdom classification. General characteristics, Outline classification and economic importance. Morphology, structure and reproduction of *Pinus* and *Ginkgo*. Evolutionary tendencies in Gymnosperms-a comparative study

UNIT – II Plant taxonomy (07 Hours)

Angiosperm systematics: Fundamental concept of Plant Taxonomy (Identification, nomenclature, classification); Taxonomic resources; Herbarium- functions and important herbaria of India and world, Botanical gardens, Flora, monographs and keys (Single-access and multi-access) herbaria of India and world, Botanical gardens, Flora, monographs and keys (Single access andmultiple access)

UNIT – III Classification **(04 Hours)**

Historical background of plant classification; Artificial (Linnaeus), Natural (Bentham and Hooker), Phylogenetic system of classification; APG system.

UNIT – IV Diversity of Chordates **(11 Hours)**

Introduction to Biodiversity, types of Biodiversity, General characteristics and Classification of chordates (upto order): Protochordata, Aganatha, Pisces: Osteichthyes, Chondrichthyes, Amphibia, Reptilia, Aves and Mammals.

UNIT – V Biogeography **(04 Hours)**

Zoogeographical realms, Distribution of vertebrates in different realms

Practical component: 60 Hours

FLORA

1. *Cycas*: T.S (temporary mount) leaf, specimen: male cone and megasporophyll; T.S.corolloid root (temporary mount), T.S. microsporophyll, L.S. ovule (permanent slides).
2. *Pinus:* Study of morphology, dwarf and long shoots, male and female cone, T.S. needle(temporary mount), L.S. male and female cone (permanent slides).
3. Study the characteristic features of ***any one*** member of the family:
   (a) Malvaceae
   (b) Fabaceae/Lamiaceae
   (c) Euphorbiaceae
   (d) Asteraceae
   (e) Liliaceae
4. Mounting of a properly dried and pressed specimen of any wild plant with herbariumlabel (to be submitted on the herbarium sheet with appropriate label)

FAUNA

5. Study of following specimens: Balanoglossus, Amphioxus, Petromyzon, Pristis, Hippocampus, Labeo, Icthyophis/Uraeotyphlus, Salamander, Draco, Naja, any two common birds.
6. Slide/ Virtual demonstration of Placoid, Ctenoid and Cycloid scales
7. Identification and classification of one endangered amphibian, reptile, bird and mammalof any one zoogeographical region in Indian.
8. Report on: Biodiversity Park/reserve/ NBPGR.

Essential/recommended readings

1. Young, J. Z., (2004). The Life of Vertebrates. III Edition. Oxford university press.

2. Parker T.J. and Haswell W.A. Textbook of Zoology Vertebrates. VII Edition, Volume II
3. Darlington P.J. The Geographical Distribution of Animals, R.E. Krieger Pub. Co.
4. Kaur I., Uniyal P.L. (2019). *Text Book of Gymnosperms*. New Delhi, Delhi: Daya Publishing House.
5. Vashistha, B.R., Sinha, A.K., Kumar, A. (2010). *Botany For Degree Students, Gymnosperms*. New Delhi, Delhi: S Chand Publication.
6. Bhatnagar, S.P., Moitra, A. (1996). *Gymnosperms*. New Delhi, Delhi: New Age International (P) Ltd Publishers.
7. Singh, G., (2018). *Plant Systematics: Theory and Practice*. Oxford & IBH Publishing Co. Pvt. Ltd.

Suggested readings

1. Ennos, R., & Sheffield, E., (2000). Plant Life. UK: University Press, Cambridge.
2. Ingrowille, M., (1992). Diversity and Evolution of land plants. Chapman and Hall
3. Wilson, E. O., (1998). Biodiversity. National Academic Press.
4. Pough H. Vertebrate life. VIII Edition, Pearson International.
5. Simpson, M.G. (2010). *Plant Systematics*. Elsevier Academic Press, San Diego, CA, U.SA

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE –6 :

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Chemical Energetics, Ionic Equilibria and Nanomaterials, (BS-DSC-203))	**4**	**2**	**0**	**2**	Class XII pass with Biology and chemistry, as one of the papers in Class XII	**Nil**

Learning Objectives

The Learning Objectives of this course are as follows:

- To introduce materials at nanoscale, their preparation, characterization techniques and applications in real life.
- Develops basic understanding of the chemical energetics, laws of thermodynamics, chemical and ionic equilibrium.
- It provides basic understanding of the behaviour of electrolytes and their solutions.
- The course will also cover thermodynamic studies with the calculation of energies and interaction of biomolecules withtheir neighbouring environment.

Learning outcomes

By the end of the course, the student will be able to:

- Understand the concept of nano-dimensions.
- Know the various methods of preparation of nanomaterials.
- Know the different characterization techniques used for the analysis of nanomaterials andunderstand the basic principle behind these techniques.
- Understand the diverse properties of nanostructures.
- Appreciate the real-world applications of nanomaterials.
- Understand the laws of thermodynamics, basic principles of thermochemistry andequilibria and successfully extend the concepts learnt in this course to biological systems.
- Understand concept of pH and its effect on the various physical and chemical propertiesof the compounds.
- Use the concepts learnt to predict feasibility of chemical reactions and to study thebehaviour of reactions in equilibrium.
- Explain the concept of ionization of electrolytes with emphasis on weak acid and baseand hydrolysis of salt.
- Apply the concepts of pH and electrolytes while studying other chemistry courses andeveryday life.

SYLLABUS OF DSC-3

UNIT – I Nanomaterials of Biological importance (15 Hours)

Overview of nanomaterials, classification, properties, role of size, methods of synthesis (Chemical methods: chemical reduction, coprecipitation, sol-gel, microemulsions or reverse micelles, solvothermal synthesis, Green or biological methods using bacteria, Fungi, etc, Plants based methods using tea leaves, cinnamon bark, etc), characterization techniques (UV-Vis, IR, SEM, TEM, XRD), optical properties of gold and silver metallic nanoparticles, concept of surface plasmon resonance, carbon nanotubes, inorganic nanowires, quantum dots & semiconductor nanoparticles, metal-based nanostructures (Iron Oxide & ZnO nanoparticles), polymer-based nanostructures, protein-based Nanostructures, natural and artificial nanomaterials, bionanomaterials and bio-nanocomposites, bioinorganic nanomaterials, DNA and its nanomaterials, biomimetics, self-assembled nanostructures, control of nanoarchitecture, Applications of nanomaterials in drug delivery, tissue engineering, medicine, orthopaedics, bioimaging, dental implants and biosensors

UNIT – II Chemical energetics (05 Hours)

Review of laws of thermodynamics, important principles and definitions of thermochemistry, concept of standard state and standard enthalpies of formations, enthalpy of neutralization, integral and differential enthalpies of solution and dilution, calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, Statement of third law of thermodynamics and calculation of absolute entropies of substances.

UNIT – III Ionic Equilibria (10 Hours)

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, Ostwald's dilution law, ionization constant and ionic product of water, ionization of weak acids and bases, pH scale, common ion effect, salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions and their applicationsin biological systems, Henderson-Hasselbalch equation. Solubility and solubility product ofsparingly soluble salts – applications of solubility product principle.

Practical component: TOTAL HOURS: 60

1. Synthesis of silver nanoparticles (AgNPs) by chemical reduction method and theirspectroscopic characterization using UV-visible spectrophotometer.
2. Green synthesis of silver nanoparticles (AgNPs) using soluble starch or cinnamon barkand their characterization using UV-visible spectroscopy.
3. Phytochemicals mediated synthesis of gold nanoparticles (AuNPs) using tea leaves and tostudy the effect of size on color of gold nanoparticles.
4. Preparation of magnetic nanoparticles (MNPs) of Fe_3O_4 using green tea leaf extract.
5. Synthesis of pure ZnO and Cu-doped ZnO nanoparticles by precipitation method and itscharacterization using UV-visible spectroscopy.
6. XRD pattern of nanomaterials and estimation of particle size. (Students can be providedwith XRD patterns of known materials and asked to interpret the data.)
7. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
8. Determination of integral enthalpy (endothermic and exothermic) solution of salts.
9. Preparation of buffer solutions: (i) Sodium acetate-acetic acid or (ii) Ammoniumchloride-ammonium acetate.
10. Measurement of the pH of buffer solutions and comparison of the values with theoreticalvalues.

11. pH metric titration of (i) strong acid with strong base, (ii) weak acid with strong base anddetermination of dissociation constant of a weak acid.

Essential/recommended readings

1. Atkins, P., Overton, T., Rourke, J., Weller, M. & Armstrong, F. (2011-12).
2. Shriver and Atkins' Inorganic Chemistry. Oxford, UK: Oxford University Press.
3. Poole Jr.; Charles P.; Owens, Frank J. (2003), Introduction to Nanotechnology, JohnWiley and Sons.
4. Malhotra, P.; Gulati, S., Novel Inorganic Solids and Nanomaterials, (2022) I.K.International Pvt Ltd.
5. Gulati, S., Sharma, J. L., Manocha, S. (2017). Practical Inorganic Chemistry. New Delhi,India: CBS publishers and distributors Pvt. Ltd.
6. Orbaek, W.; McHale, M.M.; Barron, A. R.; Synthesis and Characterization of Silver Nanoparticles for An Undergraduate Laboratory, J. Chem. Educ. 2015, 92, 339−344.
7. Gulati, S.; Shukla, S.; Kumar, S., Practical Green Chemistry, Strategies, Tools &Experiments, SKP Publishers and Distributors, 2019.
8. Shukla, S.; Gulati, S.; Kumar, S., A textbook of Green Chemistry, Benign by Design,SKP Publishers and Distributors, 2019.
9. Ghorbani H.R.; Mehr, F.P; Pazoki, H; Rahmani, B.M.; Synthesis of ZnO Nanoparticlesby Precipitation Method, Orient J Chem 2015, 31(2).
10. Kumar, S., Kapoor, V, Gulati, S, Experiments in Physical Chemistry, (2017), Book AgeSeries.
11. Kapoor, K.L. (2017). A Textbook of Physical Chemistry, Thermodynamics and ChemicalEquilibrium, Vol. 2. India: McGraw-Hill Education.
12. Khosla, B. D., Garg, V. C., Gulati, A. (2011). Senior Practical Physical Chemistry. NewDelhi, India: R. Chand & Co.
13. Rastogi, R. P., Mishra, R. R. (2009). *An Introduction to Chemical Thermodynamics*.India: Vikas Publication.
14. Atkins, P.W.; Paula, J.de. (2014), Atkin's Physical Chemistry Ed., 10th Edition, OxfordUniversity Press.
15. Ball, D. W. (2017), Physical Chemistry, 2nd Edition, Cengage Learning, India.
16. Castellan, G. W. (2004), Physical Chemistry, 4th Edition, Narosa.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DEPARTMENT OF ENVIRONMENTAL SCIENCE

Category-I
BSC (H) ENVIRONMENTAL SCIENCE

DISCIPLINE SPECIFIC CORE COURSE – 4 (DSC-EVS-4): WATER AND WATER RESOURCES

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
WATER AND WATER RESOURCES	4	2	0	2	Class XII pass	NIL

Learning objectives
The Learning Objectives of this course are as follows:
- Gain insights into the hydrological cycle, properties of water, physico-chemical and biological
- Understand parameters and indies of water quality
- Classify types of water resources and thus develop practices for their sustainable use and management
- Investigate problems associated with water shortages in India and familiarize with case studies on international and national conflicts on water.

Learning outcomes
After this course, students will be able to learn the following skills.
- Acquire skills to identify potential water resources in a given region and manage existing water resources
- Analyze data on water resources to understand the current environmental challenge and prevent the future ones
- Make informed decisions on using and choosing appropriate methods for water resource management and develop nature-based methods to improve the health of water bodies
- Develop low-cost methods for purifying drinking and natural water
- Correlate water resource management practices with socio-economic challenges and prospects
- Relate and interpret the data on water resources data with other related sustainability challenges

SYLLABUS OF DSC-4
Theory (02 Credits: 30 lectures)

UNIT – I Introduction (2 Hours)
Sources and types of water; hydrological cycle; precipitation, runoff, infiltration, evaporation, evapo- transpiration; classification of water resources (oceans, rivers, lakes and wetlands).

UNIT – II Properties of water (4 Hours)
Physical: temperature, colour, odour, total dissolved solids and total suspended solids; Chemical:major inorganic and organic constituents, dissolved gases, DO, COD, BOD, acidity and alkalinity, electrical conductivity, sodium adsorption ratio; Biological: phytoplankton, phytobenthos,zooplankton, macro-invertebrates and microbes.

UNIT – III Surface and subsurface water (6 Hours)
Introduction to surface and ground water; surface and ground water pollution; water table; vertical distribution of water; formation and properties of aquifers; techniques for ground water recharge; river structure and patterns; watershed and drainage basins; importance of watershed and watershed management; rain water harvesting in urban settings.

UNIT – IV Wetlands and their management (4 Hours)
Definition of a wetland; types of wetlands (fresh water and marine); ecological significance of wetlands; threats to wetlands; wetland conservation and management; Ramsar Convention, 1971;major wetlands of India.

UNIT –V Marine resource management (3 Hours)
Marine resources; commercial use of marine resources; threats to marine ecosystems and resources; marine ecosystem and resource management (planning approach, construction techniques and monitoring of coastal zones).

UNIT – VI Water resources in India (4 Hours)
Demand for water (agriculture, industrial, domestic); overuse and depletion of surface and ground water resources; water quality standards in India; hot spots of surface water; role of state in water resources management.

UNIT –VII Water resource conflicts (4 Hours)
Water resources and sharing problems, case studies on Kaveri and Krishna River water disputes; Multipurpose River valley projects in India and their environmental and social impacts; case studies of dams; Narmada and Tehri dam – social and ecological losses versus economic benefits; International conflicts on water sharing between India and her neighbours; agreements to resolve these conflicts.

UNIT – VIII Major laws and treaties (3 Hours)
National water policy; water pollution (control and prevention) Act 1972; Indus water treaty; Ganges water treaty; Teesta water treaty; National River linking plan: ecological and economic impacts.

Practicals/Hands-on Exercises – based on theory **(02 Credits: 60 hours)**

1. Estimate water quality based on physico-chemical parameters, such as pH, electrical conductivity, salinity, total dissolved and suspended solids, iron contents, and dissolved oxygen
2. Classify and characterize aquifers of Indian states and analyse “Safe” and “Over-exploited” zones of two states based on groundwater use.

3. Determine alkalinity, alkalinity hazard and SAR of water samples and recommend their use for various purposes.
4. Identify and map water resources in NCT Delhi and correlate its current status with changing land use in past 60 years
5. Estimate sediment load in Yamuna River at different sections of its course in Delhi regions
6. Assess water quality (pH, TDS, TH, EC, BOD, Heavy Metals) and determine the water portability of samples collected from different sites of NCT Delhi.
7. Conduct an online survey to assess people's knowledge, perception and attitude towards water quality issues and their impact on the environment and health.
8. Analyze water conservation strategies in North-eastern and Western states of India from the data available from State Government Agencies.
9. Document and compare water conservation strategies in different agroclimatic zones of India
10. Analyze watershed management strategies in selected river basins of India.
11. Develop integrated water management strategies for two contrasting river basin of India.

Essential/recommended readings

- McNabb, D.E., 2017. *Water Resource Management: Sustainability in An Era of Climate Change*. Springer.
- Loucks, D.P., Stedinger, J.R. & Haith, D. A. 1981. *Water Resource Systems Planning andAnalysis*. Englewood Cliffs, NJ, Prentice Hall.
- Brebbia, C.A. 2013. *Water Resources Management VII*. WIT Press.
- CEA. 2011. *Water Resources and Power Maps of India*. Central Board of Irrigation & Power.
- Bogardi, J.J., Gupta, J., Nandalal, K.W., Salamé, L., van Nooijen, R.R., Kumar, N., Tingsanchali, T., Bhaduri, A. and Kolechkina, A.G. eds., 2021. *Handbook of Water Resources Management: Discourses, Concepts and Examples*. Springer International Publishing.
- de Oliveira Vieira, E., Sandoval-Solis, S., de Albuquerque Pedrosa, V. and Ortiz-Partida, J.P., 2020. *Integrated Water Resource Management*. Springer International Publishing.
- Garg, V., Singh, V.P. and Raj, V. eds., 2017. *Development of Water Resources in India*. Springer International Publishing.
- Grigg, N.S., 2016. *Integrated Water Resource Management: An interdisciplinary Approach*. Springer.
- Mimikou, M.A., Baltas, E.A. and Tsihrintzis, V.A., 2016. *Hydrology and Water Resource Systems Analysis*. CRC Press.
- Vickers, A. 2001. *Handbook of Water Use and Conservation*. WaterPlow Press.

Suugested readings

- Bansil, P.C. 2004. *Water Management in India*. Concept Publishing Company, India.
- Hidalgo, M.E.A., 2013. A Decision Framework for Integrated Wetland-River Basin Management in a Tropical and Data Scarce Environment: UNESCO-IHE PhD Thesis. CRC Press.
- Information Resources Management Association (Editor) (2017). *Hydrology and Water Resource Management: Breakthroughs in Research and Practice*, 1st edition IGI Global.

- Mays, L.W. 2006. *Water Resources Sustainability*. The McGraw-Hill Publications.
- McNabb, D.E., 2017. *Water Resource Management: Sustainability in An Era of Climate Change*. Springer.
- Schward & Zhang, 2003. *Fundamentals of Groundwater*. John Willey and Sons.
- Souvorov, A.V. 1999. *Marine Ecologonomics: The Ecology and Economics of Marine Natural Resource Management*. Elsevier Publications.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 5 (DSC-EVS-5): LAND AND SOIL: CONSERVATION AND MANAGEMENT

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
LAND AND SOIL: CONSERVATION AND MANAGEMENT	**4**	**2**	**0**	**2**	**Class XII pass**	**NA**

Learning objectives

The Learning Objectives of this course are as follows:

- Gain insights into fundamentals of land and soil degradation
- Understand deeply the properties of soil and how the quality of land and soil degrades due to anthropogenic activities
- Develop solutions to combat land and soil degradation based on natural processes

Learning outcomes

After this course, students will be able to

- Acquire skills in managing soil and land sustainably
- Analyze data on soils and land use to identify the principal factor(s) governing sustainability
- Develop methods to address environmental issues related to soil health and changing land use
- Correlate positive or negative impacts of soil and land use on ecosystems and society
- Relate and interpret the soil and land use data with the sustainability of a region
- Use soil and land use data to develop evidence-based land use guidelines

SYLLABUS OF DSC-2

Theory (02 Credits: 30 lectures)

UNIT – I Introduction (3 Hours)
Land as a resource, soil health; ecological and economic importance of soil; types and causes of soil degradation; impact of soil loss and soil degradation on agriculture and food security; need for soil conservation and restoration of soil fertility.

UNIT – II Fundamentals of soil science (5 Hours)
Soil formation; classification of soil; soil architecture; physical properties of soil; soil texture; soil water holding capacity; soil temperature; soil colloids; soil acidity and alkalinity; soil salinity and sodicity; soil organic matter; micronutrients of soil; nitrogen, sulphur, potassium and phosphoruseconomy of soil; soil biodiversity; soil taxonomy maps.

UNIT – III Soil degradation – causes (5 Hours)
Soil resistance and resilience; nature and types of soil erosion; non-erosive and erosive soil degradation; losses of soil moisture and its regulation; nutrient depletion; soil pollution due to mining and mineral extraction, industrial and urban development, toxic organic chemicals, and organic contaminants in soils; fertilizers and fertilizer management; recycling of soil nutrients.

UNIT – IV Landuse changes and land degradation (7 Hours)
Land resources: types and evaluation; biological and physical phenomena in land degradation; visual indicators of land degradation; drivers of land degradation - deforestation, desertification; habitat loss, loss of biodiversity; range land degradation; land salinization; human population pressure, poverty, socio-economic and institutional factors; drivers of land use and land cover change in major geographic zones and biodiverse regions with particular reference to the Himalaya and the Western Ghats.

UNIT – V Costs of land degradation (7 Hours)
Economic valuation of land degradation; onsite and offsite costs of land degradation; loss of ecosystem services; effects on farming communities; effects on food security; effects on nutrient cycles; future effects of soil degradation; emerging threats of land degradation to developing countries.

UNIT – VI Controlling land degradation (3 Hours)
Sustainable land use planning; role of databases and data analysis in landuse planning control and management; land tenure and land policy; legal, institutional and sociological factors; participatory land degradation assessment; integrating land degradation assessment into conservation.

Practicals/Hands-on Exercises – based on theory (02 Credits: 60 hours)

1. Determine and assess soil texture, color, structure, water, and temperature using the jar test and soil textural triangle. Discuss and describe the soil profiles for different types of ecosystems.
2. Characterize the given soil samples for the proportion of soil particle size fractions.
3. Determine bulk density, moisture content, and water holding capacity of garden soil and compare it with other soil types

4. Estimate variations in pH, alkalinity, acidity, and salinity of the given soil sample. Establish the relationship between soil quality and crop productivity.
5. Evaluate given soils samples for soil organic matter contents and comment on their productivity
6. Calculate permeability of soil samples and comment on its impact on plant growth
7. Separate minerals using the selective dissolution method
8. Estimate PO_4-P of soils using ammonium molybdate reactions by spectrophotometric analysis
9. Estimate SO_4-S contents of soils by titrating with the barium chloride solution
10. Extract, investigate and interpret soil health data (micronutrient status, macronutrient status, and pH) for Northern, Western, and North-Eastern states of India. For the selected states, discuss the various soil types, agriculture practices, cropping patterns, crop production, conservation, and management strategies.
11. Extract, investigate and interpret the available datasets on soil maps, soil databases, and land degradation maps for India and draw suitable inferences. Conduct a perception-based study on the importance of soils and various impacts of soil and land degradation through an online survey.
12. Assessment of fertilizer management and integrated nutrient management practices for selected crops in India.

Essential/recommended readings

- Brady, N.C. & Well, R.R. 2007.*The Nature and Properties of Soils* (13th edition), Pearson Education Inc.
- Hazelton, P. and Murphy, B., 2021. *Understanding Soils in Urban Environments*. CSIRO publishing.
- Johnson, D.L. 2006. *Land Degradation* (2nd edition). Rowman & Littlefield Publishers.
- Kutz, M., 2018. *Handbook of Environmental Degradation of Materials*. William Andrew.
- Mir, B.A., 2021. *Manual of Geotechnical Laboratory Soil Testing*. CRC Press.
- Pansu, M. and Gautheyrou, J., 2007. *Handbook of Soil Analysis: Mineralogical, Organic and Inorganic Methods*. Springer Science & Business Media.
- Peterson, G. D., Cumming, G. S. & Carpenter, S. R. 2003. Scenario planning: a tool for conservation in an uncertain world. *Conservation Biology* 17: 358-366.

Suugested readings

- Fahad, S., Sonmez, O., Saud, S., Wang, D., Wu, C., Adnan, M. and Turan, V. eds., 2021. *Sustainable Soil and Land Management and Climate Change*. CRC Press.
- Jones, J.B., 2001. *Laboratory Guide for Conducting Soil Tests and Plant Analysis*. CRC press.
- Loconto, P.R., 2022. *Laboratory Experiments in Trace Environmental Quantitative Analysis*. CRC Press.
- Marsh, W. M. & Dozier, J. 1983. *Landscape Planning: Environmental Applications*. John Wileyand Sons.
- Patnaik, P., 2017. *Handbook of Environmental Analysis: Chemical Pollutants in Air, Water, Soil, and Solid Wastes*. CRC Press.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 6 (DSC-EVS-6): ECOLOGY AND ECOSYSTEMS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
ECOLOGY AND ECOSYSTEMS	4	2	0	2	Class XII pass	NIL

Learning objectives
The Learning Objectives of this course are as follows:
- Develop an understanding of ecosystems and their structural and functional aspects
- Reveal interconnectedness and interdependentness among all the biotic and abiotic components of the environment
- Gain insights into the dynamic nature of the ecological processes in maintaining equilibrium in nature.

Learning outcomes
After this course, students will be able to
- Acquire skills in ecological census techniques
- Analyze the status of biodiversity and ecosystem structure
- Develop methods to assess the changes in ecosystems with time and space
- Correlate effects of anthropogenic factors on ecosystem stability
- Relate and interpret the connections between environmental factors and ecosystem changes
- Use ecological data to predict the impact of a given factor on ecosystem and biodiversity

SYLLABUS OF DSC-6
Theory (02 Credits: 30 lectures)

UNIT – I Introduction (3 Hours)
Basic concepts and definitions: ecology, landscape, habitat, ecozones, biosphere, ecosystems, ecosystem stability, resistance and resilience; autecology; synecology; major terrestrial biomes.

UNIT – II Ecology of individuals (5 Hours)
Ecological amplitude; Liebig's Law of the Minimum; Shelford's Law of Tolerance; phenotypic plasticity; ecotypes; ecoclines; acclimation; ecological niche; types of niches: Eltonian niche, Hutchinsonian niche, fundamental niche, realized niche; niche breadth; niche partitioning; niche differentiation; thermoregulation; strategies of adaptation in plants and animals.

UNIT – III Ecology of populations (5 Hours)
Concept of population and meta-population; r- and K-selection; characteristics of population: density, dispersion, natality, mortality, life tables, survivorship curves, age structure; population growth: geometric, exponential, logistic, density-dependent; limits to population growth; deterministic and stochastic models of population dynamics; ruderal, competitive and stress-tolerance strategies.

UNIT – IV Ecology of communities (5 Hours)
Discrete versus continuum community view; community structure and organization: physiognomy, sociability, species associations, periodicity, biomass, stability, keystone species, ecotone and edge effect; species interactions: mutualism, symbiotic relationships, commensalism, amensalism, protocooperation, predation, competition, parasitism, mimicry, herbivory; ecological succession: primary and secondary successions, models and types of successions, climax community concepts, examples of succession.

UNIT – V Ecosystem ecology (5 Hours)
Types of ecosystem: forest, grassland, lentic, lotic, estuarine, marine, desert, wetlands; ecosystem structure and function; abiotic and biotic components of ecosystem; ecosystem boundary; ecosystem function; ecosystem metabolism; primary production and models of energy flow; secondary production and trophic efficiency; ecosystem connections: food chain, food web; detritus pathway of energy flow and decomposition processes; ecological efficiencies; ecological pyramids: pyramids of number, biomass, and energy.

UNIT – VI Biogeochemical cycles and nutrient cycling (4 Hours)
Carbon cycle; nitrogen cycle; phosphorus cycle; sulphur cycle; hydrological cycle; nutrient cycle models; ecosystem input of nutrients; biotic accumulation; ecosystem losses; nutrient supply and uptake; role of mycorrhizae; decomposition and nutrient release; nutrient use efficiency; nutrient budget; nutrient conservation strategies.

UNIT – VII Biological invasions (3 Hours)
Concept of exotics and invasives; natural spread versus man-induced invasions; characteristics of invaders; stages of invasion; mechanisms of invasions; invasive pathways; impacts of invasion on ecosystem and communities; invasive ecogenomics – role of polyploidy and genome size in determining invasiveness; economic costs of biological invasions.

Practicals/Hands-on Exercises – based on theory (02 Credits: 60 hours)

1. Using and choosing quadrat types for vegetation analyses
2. Carry out vegetation analysis using line-transect techniques
3. Estimate the populations of aquatic beetles and bugs in ponds by the mark-capture method
4. Conduct bird surveys in your college/nearby garden using the point transect method
5. Determine the variations in abundance of micro-, meso-, and macrofauna in soils of different land use
6. Estimate the diversity of species within a community or habitat and comment

on alpha diversity

7. Analyze the rate and extent of change in species along a gradient from one habitat to others and comment on beta diversity
8. Considering the analyses of practicals 6 and 7, estimate the gamma diversity and comment.
9. Prepare and interpret the species accumulation curve for the total species richness of an area

10-13 Compare and classify communities for (a) similarity and differences, (b) influential environmental variables, (c) interspecific association

Essential/recommended readings

- Gurevitch, J., Scheiner, S. M., & Fox, G. A. 2020. *The Ecology of Plants. 3rd Ed.* Sinauer associatesincorporated.
- Henderson, P.A., 2009. *Practical Methods in Ecology*. John Wiley & Sons.
- Jorgensen, S.E. ed., 2009. *Ecosystem Ecology*. Academic press.
- Morin, P.J., 2009. *Community Ecology*. John Wiley & Sons.
- Odum, E.P. 1971. *Fundamentals of Ecology*. W.B. Sounders.
- Rockwood, L.L., 2015. *Introduction to Population Ecology*. John Wiley & Sons.
- Sutherland, W.J. ed., 2006. *Ecological Census Techniques: A Handbook*. Cambridge university press.

Suugested readings

- Groom. B. & Jenkins. M. 2000. *Global Biodiversity: Earth's Living Resources in the 21stCentury.* World Conservation Press, Cambridge, UK.
- Loreau, M. & Inchausti, P. 2002. *Biodiversity and Ecosystem Functioning: Synthesis and Perspectives.* Oxford University Press, Oxford, UK.
- Pastor, J., 2008. Mathematical Ecology of Populations and Ecosystems. John Wiley & Sons.
- Pimentel, D. (Ed.). 2011. *Biological invasions: Economic and Environmental Costs of Alien Plant, Animal, and Microbe Species*. CRC Press.
- Ranta, E., Lundberg, P. and Kaitala, V., 2005. Ecology of Populations. Cambridge University Press.
- Wilson, E. O. 1985. The biological diversity crisis. *BioScience* **35**: 700-706.

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GENERIC ELECTIVES (GE-EVS-05): CIRCULAR ECONOMY AND ENVIRONMENTAL SUSTAINABILITY

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
CIRCULAR ECONOMY AND ENVIRONMENTAL SUSTAINABILITY	4	2	0	2	Class XII pass	NIL

Learning objectives

The Learning Objectives of this course are as follows:

- Critically evaluate five mega trends involving climate, development, ecology, economy, and technology and their linkages with energy and resources
- Inculcate principles and methods of circular economy and design resource-efficient, low carbon paradigm.
- Analyze business models/institutes/communities and associated processes and services and develop recommendations for integrating principles of circular economy
- Adopt routes of circular economy in personal, family, community, and institutional settings.

Learning outcomes

After the course, the students will be

- Equipped with tools and techniques of circular economy to develop a sustainable institute or community
- Acting as a consultant to industries and international organizations aiming for a circular economy
- Serving as a catalyst in evolving an ecoliterate society and industry and promoting sustainable polices

SYLLABUS OF GE-1

Theory (02 Credits: 30 lectures)

UNIT – I Circular economy (3 Hours)

Concept and definitions; Closed loop ecosystems; Systems thinking; Benefits to environment, economy and society (03 lecture)

UNIT – II Principles of circular economy (4 Hours)

Sustainable procurement; Ecodesign; Industrial and territorial ecology; Economics of functionality; Responsible consumption; Extending the duration of use; Recycling (04 lecture)

UNIT – III Steps for transition towards a circular economy (7 Hours)
Large-scale transition to non-polluting sources of energy; Durable products requiring less materials and energy; Incentivization of recycling, re-use, and repair; Replacement of hazardous materials with safer alternatives (07 lecture)

UNIT – IV Circular economy implementation (7 Hours)
Micro-level: Firm-level engineering and managerial level; Meso-level: Industrial ecology, Industrial symbiosis, Eco-clusters, Eco-industrial parks; and Macro level: General policies, Plans, Green and sustainable entrepreneurship. (07 lecture)

UNIT –V Challenges in implementing circular economy (7 Hours)
Achievability and desirability; Disrupting consumer's convenience; Local regulations versus the circular economy concept; Lack of infrastructure for waste treatment; Lack of recycling technology; Poor business model plan (07 lecture)

UNIT –VI Case studies from India and other parts of the world (2 Hours)

Practicals/Hands-on Exercises – based on theory (60 hours)

1. Evaluate the status of your institute with respect to efforts on circular economy using qualitative and quantitative surveys
2. Survey your institute and depict the journey of waste in your institute highlighting the factors/actors that are barrier to and facilitator of complete waste recycling
3. Collect spatial and temporal data on types of wastes being generated and identify the recycling hotspots and the gap in adopting circular economy principles
4. Based on activities 1 – 3, develop a consolidated waste recycling plan highlighting targets for Institute and each Department
5. Recycle and reuse the waste clothes produced at home and make a presentation in the class to increase their lifecycle and estimate its impact on ecological footprint of the family/institute
6. Coordinate with different groups working on waste recycling focusing on different types of wastes segregated at home/institute, for example, plastics/ glass/furniture/ metal/cans/paper waste and present as group activity
7. Visit an industrial area to analyse the status of circular economy concepts being practiced and give recommendations to improve the industrial sustainability (submit the report)
8. Conduction workshop in the Institute to educate students of other courses for converting wastes into useful products
9. Run a repair café where students and staff bring their broken stuff and get it repaired with the help of experts available at the Institute
10. Conduct a swap shop and swap party where people bring their old clothes for exchange
11. Estimate the impact of activities 8–10 reduction in ecological footprints
12. Conduct a drive to collect e-waste from the institute and the neighbourhood localities and donate it to the recycling facilities and estimate its impact on environment.
13. Based on the activities 1–12, plan and conduct awareness camps in the neighbourhood to educate and motivate people about importance of reuse and recycling and empower them with recycling methods

Essential/recommended readings

- Charter, M. ed., 2018. *Designing for the Circular Economy*. Routledge, London, UK.
- Hawken, P., Lovins, A.B. and Lovins, L.H., 2013. *Natural Capitalism: The Next Industrial Revolution*. Routledge.
- Lacy, P. and Rutqvist, J., 2015. *Waste to Wealth: The Circular Economy Advantage*. London: Palgrave Macmillan.
- Mavropoulos, A. and Nilsen, A.W., 2020. *Industry 4.0 and Circular Economy: Towards a Wasteless Future or A Wasteful Planet*? John Wiley & Sons.
- Stahel, W.R. and MacArthur, E., 2019. *The Circular Economy: A User's Guide*. Routledge, NY, USA.

Suugested readings

- Crocker, R., Saint, C., Chen, G. and Tong, Y. eds., 2018. *Unmaking Waste in Production and Consumption: Towards the Circular Economy* (pp. 1-353). Bingley, UK: Emerald Publishing Limited.
- Delchet-Cochet, K. ed., 2020. Circular Economy: From Waste Reduction to Value Creation. John Wiley & Sons.
- Frodermann, L., 2018. *Exploratory Study on Circular Economy Approaches*. Springer, Fachmedien Wiesbaden.
- Ghosh, S.K., Samanta, S., Hirani, H. and da Silva, C.R.V. eds., 2022. *Effective Waste Management and Circular Economy: Legislative Framework and Strategies*. CRC Press.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

Credit distribution, Eligibility and Pre-requisites of the Course

GENERIC ELECTIVES (GE-EVS-6): WETLANDS FOR INDUSTRIES AND ENVIRONMENT

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
WETLANDS FOR INDUSTRIES AND ENVIRONMENT	4	2	0	2	Class XII pass	NIL

Learning objectives

The Learning Objectives of this course are as follows:

- Delineate, and classify the target wetland
- Identify common wetland plants and indicators of wetlands
- Assess landscape for wetland management and conservation
- Evolve a wetland construction and restoration plan
- Suggest appropriate changes for effective wetland regulation law and policy

Learning outcomes

After successful completion of this course, students will be able to:

- Apply basic principles of wastewater treatment for environmental and industrial applications
- Develop plans for monitoring wetland health and designing a constructed wetland
- Assess the feasibility of constructed wetlands for wastewater treatment
- Operate and maintain wetlands in nature and industries

SYLLABUS OF GE-EVS-6

Theory (02 Credits: 30 lectures)

UNIT – I Ecology and socio-economy of wetlands (11 Hours)

Wetland types and functions; Ramsar Convention, Vegetation type and dynamics; Soil types; Geology and geomorphology; Hydrological regimes: Water quality and balance, Sedimentation; Indicators; Biodiversity and its significance; Ecological and economic benefits: Provisioning, Regulating, Cultural and Supporting services, Socio-economic and cultural diversity in human society living in and around wetlands; Income and employment generation by wetlands; Community resource use and management practices. (11 lectures)

UNIT – II Wetlands and water treatments (8 Hours)

Principles and efficacy of natural wetlands; Economics of treatment; Case studies from India and other countries; Types of constructed wetlands and their principles; Potential of constructed wetlands for treating different types of wastewaters (agriculture, domestic, industry, municipal, runoff, and sludge); Operation and maintenance; Case studies from India and other countries (8 lectures)

UNIT – III Wetland management (11 Hours)

Delineation and mapping; Features and associated factors; Monitoring ecosystem health; Major threats; Setting up goals and objectives; Institutional arrangements, Wetlands ecosystem services maps; Ecosystem services trade-offs; Landscape-scale Management; Interventions to sustain biodiversity and ecosystem services; Mobilizing community participation and generating finance; Cross-sectoral integration; Integration of wetland conservation in development plans, acts, and rules; Adaptive management. (11 lectures)

Practicals/Hands-on Exercises – based on theory (02 Credits: 60 hours)

1. Identify a potential area for wetland construction, propose its purpose and goal, and develop the construction plan giving details of location, type, current land use, biodiversity, and hydrologic regime
1. Prepare water budgets and hydrographs of the selected area based on the data on water inputs and outputs collected from concerned institutes
2. Field surveys and analyze vegetation characteristics of a pristine wetland present in the nearby location of the study site
3. Analyze adaptive strategies of selected native plants to hydrologic regime suitable for wetland construction and develop planting strategies of species assemblage
4. Analyze soil type and determine its physico-chemical properties (pH, TDS, EC, CEC, Redox potential, etc.)
5. Evolve soil amendment method to improve texture, percolation, and nutrient composition. suitable for the hydrogeomorphic model and selected plant species
6. Surveying wetlands to identify suitable indicators for mapping and delineating wetlands zone of influence and evaluate anthropogenic activities as major threats to wetlands
7. Develop wetlands ecosystem services (ES) potential maps and evaluate ES trade-offs
8. Analyze different models for wetland construction and, based on the nature of the water regime and basic methods of wetland construction, recommend the hydrogeomorphic model suitable for the selected landscape

Essential/recommended readings

- Aber, J.S., Pavri, F. and Aber, S., 2012. *Wetland Environments: A Global Perspective*. John Wiley & Sons.
- Keddy, P.A., 2010. *Wetland Ecology: Principles and Conservation*. Cambridge University Press.
- Shuqing, An., and Jos, T.A. Verhoeven (Eds)., 2019. *Wetlands: Ecosystem Services, Restoration and Wise Use Series: Ecological Studies*, Volume 238, Springer, Cham.
- Stefanakis, A.I. ed., 2018. *Constructed Wetlands for Industrial Wastewater Treatment*, Wiley, Blackwell.
- Tiner, R.W., 2016. *Wetland Indicators: A Guide to Wetland Formation, Identification, Delineation, Classification, and Mapping*. CRC Press.

Suugested readings

- Austin, G. and Yu, K., 2016. *Constructed Wetlands and Sustainable Development*. Routledge.
- Lopez, R.D., Lyon, J.G., Lyon, L.K. and Lopez, D.K., 2013. *Wetland Landscape Characterization: Practical Tools, Methods, and Approaches for Landscape Ecology*. CRC Press.
- Windham-Myers, L., Crooks, S. and Troxler, T.G. eds., 2018. *A Blue Carbon Primer: The State of Coastal Wetland Carbon Science, Practice and Policy*. CRC Press.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVES (GE-EVS-7): CORPORATE, SOCIAL, AND ENVIRONMENTAL RESPONSIBILITIES FOR CONSERVATION AND SUSTAINABLE DEVELOPMENT

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
CORPORATE, SOCIAL, AND ENVIRONMENTAL RESPONSIBILITIES FOR CONSERVATION AND SUSTAINABLE DEVELOPMENT	4	2	0	2	Class XII pass	NIL

Learning objectives

The Learning Objectives of this course are as follows:

- Inculcate interdependent and interrelated theories of corporate branding, environmental sustainability, and social equity
- Understand the working and driving forces of CSR and its significance as a stepping stone to Sustainable Business Models
- Gain insights into CSR as a tool to ensure social justice and adopt environmental wisdom from industries
- Empower with emerging frameworks and practices in CSR for environmental sustainability and improve quality of life

Learning outcomes

After the course, students will be able to:

- Explain the concept of CSR from an environmental sustainability perspective and its significance in next-generation marketing strategies
- Apply concepts of CSR to develop strategies for responsible marketing, business success, and environmental protection.
- Develop systems thinking and evolve as a responsible consumer
- Decipher linkages between concepts of circular economy, sharing economy, and carbon/ecological footprints, and identify opportunities and challenges to specific businesses and target consumers.
- Gain insights into five dimensions of sustainability performance: economic, environmental, governance, social and ethical
- Practice sustainability management, implement cleaner technologies, and argue in favour of environmental protection.

SYLLABUS OF GE-EVS-7

Theory (02 Credits: 30 lectures)

UNIT – I Sustainable Development (8 Hours)

Definitions, goals and frameworks; Sustainability: Definition and concept, Bottom of the pyramid and fairtrade; Evolution of concepts, Socio-ethical and environmental aspects, Benefits in strategic planning; Associated world's leaders and corporations, Financial, social and reputational benefits, Circular and share economy (8 lectures)

UNIT – II Corporate social responsibility (CSR) (6 Hours)

CSR: Definition and concept, Philosophy and practices of CSR; Measuring CSR; Impact of CSR on rural livelihoods, natural resources management, biodiversity conservation; Carbon footprint; Cleaner technologies; Emerging CSR policies in India

UNIT – III CSR and Sustainability (9 Hours)

Why and when to apply CSR activities, Competitiveness vs Ethical, Green markets and budget, Bottlenecks of being sustainable, Public-private partnerships for socio-ecological entrepreneurship, Vocal for local embedding sustainability; Business strategies for sustainable individuals, firms, and industries, Power-Inequality-Environment-CSR nexus, Managing, Monitoring, and Reporting CSR, Beyond framing CSR as strategic, political or utopian (9 lectures)

UNIT – IV Case studies (7 Hours)

CSR applications for improving livelihoods, enhancing soil health and crop productivity in stress environment, adaptation to climate change, and diversification of crop patterns improving rural wastewater management (7 lectures)

Practicals/Hands-on Exercises – based on theory (02 Credits: 60 hours)

1. Analyze variations in CSR efforts in saving the environment by countries differing in biodiversity and ecosystem diversity
2. Critically analyze OECD Guidelines for Multinational Enterprises on corporate responsibility
3. Select a company/business organization and, based on its activities and products, identify the environmental issues that need to be addressed for societal need
4. Evaluate diverse environmental issues based on their impact on society and organizational brand value and develop its vision document and a CSR plan for environmental conservation
5. Determine priorities and evolve a code of conduct document for the selected company to maximize its CSR for environmental issues
6. Based on the activities of the target business organization, develop an action plan and policies to suit the international guidelines and standards of CSR for environmental conservation

7. Identify the constraints to implement the guidelines and standards set based on dialogue with different stakeholders and surveying the local circumstances
8. Analyze the variations in guidelines and standards to meet the CSR in countries differing in biodiversity and cultural values
9. Identify the environmental indicators to formulate a monitoring and reporting system for CSR success
10. Evolve the appropriate communication style for different internal and external stakeholders
11. Field surveys and lab-based assays for monitoring the targeted ecosystem, biodiversity, environmental compartment, and socio-ecological systems for the impact of CSR

Essential/recommended readings

- Bachnik, K., Kaźmierczak, M., Rojek-Nowosielska, M., Stefańska, M. and Szumniak-Samolej, J. (eds.), 2022. *Corporate Social Responsibility and Sustainability: From Values to Impact*. Routledge.
- Camilleri, M.A., 2017. *Corporate Sustainability, Social Responsibility and Environmental Management*. Cham, Switzerland: Springer International Publishing.
- Geoffrey H., 2010. *When Principles Pay: Corporate Social Responsibility and the Bottom Line*, Columbia University Press.
- McKenna, K., 2015. *Corporate Social Responsibility and Natural Resource Conflict*. Routledge.

Suugested readings

- Roberts, L., Georgiou, N. and Hassan, A.M., 2022. Investigating biodiversity and circular economy disclosure practices: Insights from global firms. *Corporate Social Responsibility and Environmental Management*. DOI: 10.1002/csr.2402
- Ringham, K., 2017. CSR and Sustainability: From the Margins to the Mainstream: A Textbook, Routledge
- Rendtorff, J.D., 2019. *Philosophy of Management and Sustainability: Rethinking Business Ethics and Social Responsibility in Sustainable development*. Emerald Group Publishing.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVES (GE-EVS-8): E-WASTES: LEGISLATION, TRADE AND MANAGEMENT

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
E-WASTES: LEGISLATION, TRADE AND MANAGEMENT	4	2	0	2	Class XII pass	NIL

Learning objectives

The Learning Objectives of this course are as follows:

- Define and explain e-waste and its category
- Learn effective mechanisms to regulate the generation, collection, storage, transport, import, and export,
- Empower with methods of recycling, treatment, and disposal of e-waste
- Current legislative rules for managing e-waste in the environment

Learning outcomes:

After the course, students will be able to

- Apply various concepts for e-waste management hierarchy with a holistic understanding of the environmental impacts of e-waste
- Decipher the roles of the various national and internal acts and laws applicable for e-waste management
- Evolve plans for handling e-waste to comply with its management proposed under national and global legislation
- Develop a holistic understanding of environmental impacts of e-waste, application of

SYLLABUS OF GE-EVS-8

Theory (02 Credits: 30 lectures)

UNIT – I E-waste Composition, Generation and Management (8 Hours)

Definition, Composition and generation, Global and national perspective, Co-pollutants, Hazardous properties, Effects on human health and environment, Domestic e-waste disposal, E-waste Management: Basic principles, Components, Resource recovery potential, Technologies for recovery of resources, Steps in recycling and recovery of materials-mechanical processing, Occupational and environmental health effects (8 Lectures)

UNIT – II Global trade of E-waste (7 Hours)

Factors in global waste trade economy, Waste trading and electronic recycling, Free trade agreements as a means of waste trading. Import of hazardous e-waste in India; India's stand on liberalizing import rules, E-waste economy in the organized and unorganized sector, Production and recycling of e-wastes in Indian metro cities.

UNIT – III Control measures (7 Hours)
Need for stringent health safeguards and environmental protection laws in India, Extended Producers Responsibility (EPR), Import of e-waste permissions, Producer-Public-Government cooperation, Administrative Controls & Engineering controls, monitoring of compliance of Rules, Effective regulatory mechanism strengthened by manpower and technical expertise, Reduction of waste at source.

UNIT – IV Relevant legislation (8 Hours)
Hazardous Waste Rules, 2008, E-waste (Management and Handling) Rules, 2011; and E-Waste (Management) Rules, 2016 - Salient Features and its likely implication. Government assistance for TSDFs. The international legislation: The Basel Convention; The Bamako Convention. The Rotterdam Convention. Waste Electrical and Electronic Equipment (WEEE) Directive in the European Union, Restrictions of Hazardous Substances (RoHS) Directive. (8 Lectures)

Practicals/Hands-on Exercises – based on theory (02 Credits: 60 hours)

1. Prepare inventory and estimate the magnitude of electrical and electronic waste from the home, college, or the selected site (hospitals/company/manufacturing facilities) (example, air conditioners, heaters, microwaves, batteries, digital cameras, calculators, circuit boards, monitors, VCRs/DVD players, telephone equipment, etc.)
2. Categorize e-waste into different types as per international and national guidelines
3. Prepare a list of certified electronics recyclers in your city and transport e-waste to it, and have an interactive session to learn from the processes being followed.
4. Find out the composition of e-waste and segregate it from the given materials. Recommend the internationally acceptable shredding processes for each type of e-waste.
5. Prepare a poster showing salient features of the e-waste management act of India
6. Sort electronics and prepare a list of valuables that can be extracted from electronics, such as fluorescent light and toner cartridges (metals, plastics, glass, compounds, and other elements). Identify and remove e-waste that may carry hazardous materials (like cathode ray tubes) before sending the objects for recycling.
7. Visit a nearby e-waste handling facility and learn about the dismantling of e-waste and the handling process
8. Discuss with students in groups the plausible ways and implementation of e-waste reduction at the source and how regulatory mechanisms can be utilized in the management of e-waste in educational institutions.
9. Evaluate the status of e-waste handling at your institution. Suggest potential solutions as per the existing norms of E-Waste (Management) Rules, 2016 and beyond.
10. Decipher the methods of dust extractions, magnetic and water separation, purification, and preparation for sale. Identify the material that can be repurposed.
11. Study the evolutionary history of e-waste management rules and their implementation- Hazardous Waste Rules, 2008; E-waste (Management and Handling) Rules, 2011; and E-Waste (Management) Rules, 2016
12. Compare and analyze international laws on e-waste management- the international legislations: The Basel Convention; The Bamako Convention; The Rotterdam

Convention; Waste Electrical and Electronic Equipment (WEEE) Directive in the European Union; Restrictions of Hazardous Substances (RoHS) Directive

13. Develop an understanding and itinerary of the process for procuring e-waste import permissions and inventory of the e-waste disposal mechanisms.

Essential/recommended readings

- Hester, R.E. and Harrison, R.M., 2009. Electronic Waste Management: Design. Analysis and Application. Royal Society of Chemistry Publishing. Cambridge, UK.
- Fowler, B.A., 2017. Electronic Waste: Toxicology and Public Health Issues. Academic Press.
- Eduljee, G.H. and Harrison, R.M. eds., 2019. Electronic Waste Management. Royal Society of Chemistry.

Suggested readings

- Janyasuthiwong, S., 2020. Metal Removal and Recovery from Mining Wastewater and E-waste Leachate. CRC Press.
- Gaidajis, G., Angelakoglou, K. and Aktsoglou, D., 2010. E-waste: environmental problems and current management. Journal of Engineering Science and Technology Review, 3(1), pp.193-199.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DEPARTMENT OF HOME SCIENCE

Category I

B.Sc. (Hons.) Home Science

DISCIPLINE SPECIFIC CORE COURSE – 4 (DSC HS 204): FASHION STUDIES

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
FASHION STUDIES DSC HS 204	**4**	**3**	**0**	**1**	**12th Pass**	**NIL**

Learning Objectives

1. To understand the basics of fashion and the fashion industry.
2. To impart knowledge about functions and theories of clothing.
3. To develop sensitivity towards selection of garments and garment design.

Learning Outcomes

The student will be able to:

1. Identify the role and functions of clothing and recognize the factors affecting the selection and evaluation of clothing.
2. Explain the concept of fashion, its terminology, sources and factors affecting it.
3. Being aware of global fashion centres.
4. Apply the knowledge of elements and principles in design interpretation.

SYLLABUS OF DSC-4

Unit I: Clothes and us (12 Hours)

This unit introduces the student to key concepts of how and why people started to wear clothes, and what factors are at play in the current times for selecting clothing for the individual.

- Clothing functions and theories of origin
- Clothing terminology
- Individuality and conformity, conspicuous consumption and emulation
- Body shapes
- Selection and Evaluation of quality of ready-made garments
- Selection of clothes for self

Unit II: Understanding fashion (12 Hours)

This unit will deal with the basic concepts in understanding fashion, from key terms to the why and how of fashion and more contemporary knowledge of fast and slow fashions.

- Fashion cycle
- Terminology
- Theories of fashion adoption
- Sources of fashion research
- Factors favoring and retarding fashion
- Role of a Designer
- Fast Fashion: Characteristics of Fast Fashion, Fast Fashion and Consumer
- Slow Fashion: Characteristics, Slow Fashion as a process, importance of changing from fast to slow fashion

Unit III: Design in Garments **(09 Hours)**

This unit orients the student from a design perspective in garments; the various elements that comprise a garment and the various principles that govern and guide in developing a good design.

- Structural and Decorative Design
- Elements of Design
- Principles of Design

Unit IV: Fashion **(12 Hours)**

This unit will apprise the student on the forecasting process for fashions, functioning of the industry and various garment categories for production.

- Structure and Functioning of Fashion Industry
- Forecasting: Fashion seasons
- Garment Categories
- Fashion Centers
- Careers in Fashion

ESSENTIAL READINGS

- Brown, Patty, Rice J., 1998, *Ready to Wear Apparel Analysis*. Prentice Hall.
- Marshall S G, Jackson H O, Stanley MS, Kefgen M & Specht T, 2009, *Individuality in Clothing & Personal Appearance, 6th Edition*, Pearson Education, USA.
- Tate S.L., Edwards M.S., 1982, *The Complete Book of Fashion Design*, Harper and Row Publications, New York.
- Fringes G.S., 1994, *Fashion From Concept to Consumer, 6th edition*, Prentice Hall, New Jersey.

SUGGESTED READINGS:

- R. Andrew, 2018, Key Concepts for Fashion Industry, Bloomsbury Publishing, India

PRACTICAL
(30 Hours)

Unit I: Hand stitches **(14 Hours)**

This unit will impart hands-on skill for making small products using upcycling of used articles of clothing or home textiles and how value addition may be achieved in garments by using popular embroidery stitches.

- Prepare samples of –
- Basic hand stitches for creating a seam and edge finishing.
- Decorative Hand Stitches
- Develop an upcycled product

Unit II: Elements & Principles of Design **(16 Hours)**

This unit will train the students to identify the various elements of a design that a garment uses and the principles that are creating an aesthetic design. Eventually a student will be able to effectively use these elements and principles of design to create well designed garments.

- Create a collection of garments for analysis from print and visual media.
- Analyze the various elements that comprise the garments.
  Identify the various principles of design used in the selected garments

Essential Readings

- Fringes G.S., 1994, *Fashion From Concept to Consumer, 6th edition*, Prentice Hall, New Jersey.
- Marshall S G, Jackson H O, Stanley MS, Kefgen M & Specht T, 2009, *Individuality in Clothing & Personal Appearance, 6th Edition*, Pearson Education, USA.

Suggested Readings:

- Reader's Digest (Eds.). 2002, New Complete Guide to Sewing, (Canada) Ltd. Montreal.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 5 (DSC HS 205): FUNDAMENTALS OF RESOURCE MAMAGEMENT

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
FUNDAMENTALS OF RESOURCE MANAGEMENT DSC HS 205	**4**	**3**	**0**	**1**	**12th Pass**	**NIL**

Learning Objectives

1. To enable students to understand the fundamentals of resource management in changing scenario and available resources, their uses and conservation.
2. To understand the processes of management in a scientific manner for the judicious use of resources.

Learning Outcomes

Students will be able to:

1. Comprehend the fundamentals of resource management in the changing scenario.
2. Familiarize with the available resources, their uses and conservation.
3. Utilize resources optimally in a prudent manner.
4. Understand the processes of management in a scientific manner for the use of resources.

THEORY

Unit I: Introduction to management **(12 Hours)**

Unit Description: The focus of this unit would be on understanding the concept of management, scope and approaches of management in context to changing scenario.

Subtopics:

- Concept, nature, universality and scope of management
- Theories and Approaches to management.
- Ethics in management
- Motivation in management

UNIT II: Understanding resources **(09 Hours)**

Unit Description: This unit attempts to acquaint the students with the available resources, their uses and conservation approaches.

Subtopics:

- Meaning, classification and characteristics of resources.
- Resource conservation- maximizing use of resources, factors
- affecting utilization of resources.
- Family life cycle in context to resource use: Time, energy, money.

Unit III: Functions of management: An overview **(12 Hours)**

Unit Description: This unit will orient the students in understanding the functions and processes of management in a scientific manner for the optimization of resources.

- Decision Making: Concept, significance and steps involved in decision-making process.
- Planning: Nature and characteristics, classification of plans & steps in planning.
- Organizing: Concept, significance and steps involved in organizing process.
- Supervision: Types of supervision (directing & guiding), factors of effective supervision.
- Controlling: Types of control, steps in controlling, requirements of effective control.
- Evaluation: Types and steps of evaluation.

Unit IV: Management of time and energy resources **(12 Hours)**

This unit will familiarize students with effective management of time and energy resources and their functional use in day-to-day life.

- Time Management: Concept, tools of time management, types of time plans, steps in making a time plan.
- Energy Management: Concept, principles of body mechanics, types of fatigue.
- Work Simplification: Techniques, Classes of Change.

PRACTICAL -30 Hours

Unit I: Identification and Development of managerial competencies **(14 Hours)**

Activities:

- Micro Lab and Who am I
- SWOC analysis
  - Self
  - Case studies: Individuals
  - Case studies: Organizations
- Building Decision making abilities
- Team building management games
- Decision Making: Case Analysis

Unit II: Management of Time and Energy **(16 Hours)**

Activities:

- Time Management:
  - Evaluation of time plans through case analysis:
    - Case Study-1
    - Case Study-2
  - Analysis of time use pattern of self
    - Preparation and evaluation of time plans
- Work improvement using time and motion study techniques
  - pathway chart or travel chart / process chart - observe, record, and analyze an activity.
  - pathway chart or travel chart / process chart - observe, record, and analyze an activity with improvement.

Essential Readings

- Combe, C. (2014). *Introduction to management.* Oxford University Press.
- Drucker, P. F. (2007). *Management: Tasks, responsibilities, practices.* Transaction Pub, ISBN-13: 978-0750643894.
- Goel, S. Ed. (2016). *Management of resources for sustainable development.* New Delhi: Orient Blackswan Pvt. Ltd, ISBN: 9788125063490, 9788125063490.
- Griffin, R. W. (2013). *Management: Principles and practices (11th ed.)*. South-Western Cengage Learning, ISBN: 9788131530917, 8131530914.
- Hill, C. W., & Stevenane. (2006). *Principles of management (1st ed.).* McGraw-Hill/Irwin. ISBN: 9780073530123.
- Koontz, H., & O' Donnel, C. (2005). *Management: A systems and contingency analysis of managerial functions.* New York: McGraw-Hill Book Company, ISBN-13: 978-0070853775.
- Moore, T. J. (2021). *Family resource management* (4th ed.). ISBN-13: 978-1544370620.
- Rao, V.S.P. (2008). *Principles & practice of management*. Konark Publishers Pvt. Ltd, ISBN-13: 978-8122000283.

For Practicals

- Goel, S. Ed. (2016). *Management of resources for sustainable development.* New Delhi: Orient Blackswan Pvt. Ltd, ISBN: 9788125063490, 9788125063490.
- Arora, R., Magu, P., Singh, P., Meghna, Gupta, S. (2013). *Resource Management: An Introductory Manual.* R. Gangadharan of Elite Publishing House Pvt. Ltd., Daryaganj, ISBN No: 978-81-88-901-50-0.
- Drucker, P. F. (2007). *Management: Tasks, responsibilities, practices.* Transaction Pub, ISBN-13: 978-0750643894

Suggested Readings:

- Jyoti, A. (2009). *Principles of management*. Gennext Publication. ISBN-13: 9789380222127.
- Kreitner, R. (2009). *Management*. Canada: Houghton Miffin Harcourt Publishing Company.
- Nickel, D. (2002). *Management in family living,* 4e (4th ed.), ISBN-13: 978-8123908519.
- Robbin, S.P. (2009). *Fundamentals of management,* 11th edition, Pearson Education.
- Steidl, R. & Bratton, E. (1968). *Work in the Home.* USA: John Wiley & Sons, Inc, ISBN-13: 9780471820857.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 6 (DSC HS 206): LIFE SCIENCE FOR HOME SCIENCE

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
LIFE SCIENCE FOR HOME SCIENCE DSC HS 206	**4**	**2**	**0**	**2**	**12th Pass**	**NIL**

Learning Objectives

- To impart the basic knowledge of animal diversity, plant diversity and its significance for human life.
- To make students aware of the fundamental process of plant growth and its regulation.
- To enable students to learn about methods of sustainable agriculture, plant conservation and propagation.
- To make students aware of immunology, genetics and biotechnology.

Learning Outcomes

- The students would be able to identify and appreciate some common plant and animal diversity in their vicinity.
- The students would understand the fundamentals of genetics and its significance in human life.
- The students would gain hands-on experience and training on gardening and plant propagation techniques along with the artificial methods of vegetative propagation.
- The students would acquire the basic knowledge of biotechnology along with recent trends and its applications in agriculture, animal husbandry and human welfare and associated ethical and social issues.
- The students would acquire knowledge about various zoonotic diseases, pandemics and learn about its control and management.
- The students would understand the importance prenatal screening and natal health.

THEORY

Section A – Botany

Unit I: Introduction to Plant Kingdom (08 Hours)

Plant kingdom, plant growth and regulation, Economically Important Plants

- Introduction to Plant Diversity
- Economic importance of Microbes (Industrial &Household Products, Sewage treatment, Biogas production, Biocontrol agents, Bio-fertilizers)
- Angiosperm plants: Morphology (Parts of plants with modifications and Life cycle)
- Plant Nutrition and Soil: Essential Elements and Functions, Nutrient cycles, Human Impact on nutrient cycles and effects of pollution
- Plant growth and Development- Regulation and control (Hormones)
- Enzymes: principles and biotechnological applications
- Introduction to Economically important plants: Food Crops, Fibre Crops, Medicinal Plants, Oil Crops, Timber Plants

Unit II: Propagation, Gardening and Conservation of Plants (06 Hours)

Plant propagation methods, Sustainable Agriculture, Biotechnology in Agriculture

- Seed Propagation
- Vegetative Propagation: Cuttings – stem leaf and root, Layering, Grafting, Tissue Culture
- Gardening: Concept and Types with example of Kitchen Garden, Green Roofs, Maintenance of plants
- Sustainable Agriculture: Concept of Organic farming, IPM, Biopesticides, Climate smart agriculture, Seed bank, Urban Agriculture
- Concept of Sustainable development with Sustainability Indicators
- Role of Plants in Air Pollution Control
- Principles and Applications of biotechnology in agricultural crops

Section B – Zoology

Unit III: Animal Diversity and Human Needs (08 Hours)

Animal diversity and its importance to humans

- Types, Structure and Function of Animal Cell and its components (Chromosomes and Nucleus)
- Animal diversity and its distribution
- Animals and their ecosystem services: role of animals in soil health, pollination, biological control of pests, food security
- Threatened species of animals and their conservation
- Zoonotic and Parasitic diseases- Life cycle, pathogenesis and control. (*Plasmodium*, *Giardia*, *Entamoeba*, *Taenia*, *Ascaris, Covid-19, malaria, tuberculosis*)
- Animals as economic resources: sericulture, apiculture, aquaponics (concept and applications)

Unit IV: Immunity, Genetics and Biotechnology (08 Hours)

Basics of human immunity, Pandemics, genetic diseases, application of biotechnology, developmental biology

- Basics of Human Immunity: introduction to humoral and cell mediated immunity; Vaccination
- Introduction to Pandemics and its management
- Genetic diseases and importance of Genetic counselling
- Birth defects and its causes (genetic and environmental factors)
- Application of biotechnology: Stem cells, cloning and animal improvements

PRACTICAL – 60 Hours

SECTION A- BOTANY

1. Preparation of soil mixture, potting and re-potting
2. Raising of healthy seedlings in a nursery bed
3. Assessment of soil quality: determination of soil pH, test for nitrates, nitrites
4. Propagation of plants through stem cutting, air layering and underground layering
5. Propagation of plants by approach grafting and veneer grafting
6. Identification and classification of economically important Food crops, Medicinal plants
7. Identification and classification of economically important plants: Fibre crops, Timber plants and Oil crops
8. Identification, Care and maintenance of important plants in controlling air pollution
9. A visit to Home Garden/ Organic farm/ Tissue culture Lab
10. Demonstration of Urban Home Gardens/ Kitchen Garden / Nutrition Garden
11. Study of techniques of biotechnology through audio visual aids

SECTION B- ZOOLOGY

1. Study of cell Structure through temporary slides: Blood Cells
2. Study of cell Structure through temporary slides: Neurons
3. Study of cell cycle stages through permanent slides: Mitosis
4. Study of cell cycle stages through permanent slides: Meiosis
5. Identification of few common animals and birds in the human environment
6. Estimation of species richness and abundance of animal/ birds in the human environment using point count method
7. Estimation of species richness and abundance of animal/ birds in the human environment using transect method
8. Soil biomonitoring using Burlese-Tullgren method: concept and importance of micro and macrofauna in soil health
9. Detection of chromosomal abnormalities: concepts and interpretation of diagnostic tests: Karyotyping
10. Detection of chromosomal abnormalities: concepts and interpretation of diagnostic tests: Dual marker test
11. Visit to any one of the following: Aquaponic facility/organic farm/ bee farm
12. Case study of a zoonotic/ parasitic disease: COVID-19 pandemics/ bird flu

Essential Readings

- Jordan E. L. and Verma P. S., 2009. Invertebrate Zoology, S. Chand and Co. Ltd, New Delhi.
- Park K., 2016. Textbook of preventive and social medicine. Banarsidas Bhanot Publishers.
- Raven P. and Johnson G., 2010. Biology. Tata McGraw Hill Publication, New Delhi.
- Singh J. S, Singh S. P. and Gupta S. R., 2017. Ecology, Environment Science and Resource Conservation. S. Chand (G/L) & Company Ltd, India.
- Soni N. K. and Soni V., 2010. Fundamentals of Botany. Tata McGraw Hill Publication, New Delhi.

Suggested Readings

- Chadha K. L.2012. Handbook of Horticulture. ICAR Publication, New Delhi.
- Gopalaswamiianger K.S. 1991. Complete gardening in India, Messers Nagaraj and Co., Madras.
- Gupta R. 2015. Fundamentals of Zoology: Theory and Practice. Elite Publishing House Pvt. Ltd., New Delhi.
- Hartman H.T and Kester D. 1986. Plant Propagation: Principles and Practices Prentice Hall of India Pvt. Ltd., New Delhi.
- Kotpal R. L. 2000. Modern Textbook of Zoology, Rastogi Publications, Meerut.
- Magurran, A. E. 1988. Ecological Diversity and Measurement. Croom Helm Limited, Australia.
- Upadhyay R. 2017. Elements of Plant Science, Elite Publishing House, New Delhi.

Vij, U. and Gupta, R. 2011. Applied Zoology Phoenix Publishing House, New Delhi

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

Category-II
B.Sc (Prog.) Home Science

DISCIPLINE SPECIFIC CORE COURSE – 1 (DSC HP 204) –: Lifespan Development I: Prenatal and Early Years

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Lifespan Development I: Prenatal and Early Years	4	3	0	1	12th Pass	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To acquire an understanding of lifespan development as a discipline
- To appreciate the role of heredity, context, family and community in Lifespan development
- To understand developmental progression across stages and domains of the lifespan

Learning outcomes

The Learning Outcomes of this course are as follows:

- The student will develop an understanding about the discipline of Lifespan development
- The student will appreciate principles of growth and development
- The student will understand the concept of stages and domains in lifespan development
- The student will become aware of optimal practices in child rearing and child stimulation

SYLLABUS OF DSC HP 204

Unit I: Understanding Lifespan Approaches and Perspectives – 09 Hours

The unit provides a foundational view on Life Span development.
Subtopics:

- Definitions, nature, scope and multidisciplinary nature of Lifespan Development
- Developmental stages and domains
- Principles of growth and development
- Optimizing development in early years

Unit II: Pregnancy, Birth and the Neonate – 12 Hours

The unit focuses on pregnancy and safe motherhood, understanding prenatal development and birthing techniques and the newborn.
Subtopics:

- Stages of prenatal development
- Influences on prenatal development and safe motherhood
- Birthing process and the high-risk newborns
- Newborn capacities and care

Unit III: Development during Infancy – 12 Hours

Understanding the period of infancy through the framework of developmental domains
Subtopics:

- Developmental Norms and Milestones
- Physical- motor development
- Sensory Perceptual development
- Cognitive development
- Language development
- Social development

Unit IV: Development during Preschool – 12 Hours

Understanding the domains of language, cognitive and socio-emotional development preschool period. Interlinkages between developmental domains for strong foundations.
Subtopics:

- Developmental Norms and Milestones during preschool
- Physical and motor development
- Language development
- Cognitive development
- Social and emotional development: Family, Play and Learning

PRACTICAL -30 Hours

- Introduction to research methods in Lifespan development
- Documentation of methods: Interview, Observation and Narrative
- Prepare interviews to explore cultural practices and conceptions related to pregnancy, infancy and early childhood
- Conduct early childhood observations using specimen description and checklist in *any two* domains of development
- Using audio and video resources to study prenatal development, infancy and early childhood
- Preparation of activities and learning aids for parents using locally available materials
- Mapping resources in children's ecology by community survey
- Psychological tests- Developmental assessment of Indian children, WPPSI

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Essential Readings

- Berk, L. (2013). Child development. 9th ed. Boston: Pearson.
- Rice, F. P. (1998). Human Development: A Life-span Approach. New Jersey: Prentice Hall.
- Santrock, J. W. (2011). Life-span development. New York: McGraw-Hill.
- Singh, A. (Ed.) 2015. Foundations of Human Development. New Delhi: Tata McGraw-Hill.
- Snow, C. W., & McGaha, C. G. (2003). Infant development (3rd ed.). Upper Saddle River, NJ: Prentice Hall.

Suggested Readings

- Childhood in south Asia: A critical look at issues, policies and programmes. Conn.USA:Information Age.
- Hospital walls. In T.S. Saraswathi (Ed.). Culture, socialization and human development. New Delhi: Sage.
- Singhi, P. (1999). Child health & well-being: Psychological care within & beyond
- Sriram, R. (2004). Ensuring infant and maternal health in India. In J. Pattnaik (Ed.).
- Verma, P, Srivastava, D.N. and Singh, A. (1996). Bal *manovigyan and bal vikas.* Agra: Chapter 3: Indian women: Traditional and modern: pages 52-70.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 2 (DSC HP 205): Foundation of Food Science and Nutrition

Credit distribution, Eligibility and Prerequisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Foundation of Food Science and Nutrition	4	3	0	1	12th Pass	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To understand functions of food and the relationship between food, nutrition and health.
- To describe the functions of various nutrients, their sources and clinical manifestations of excess/ deficiency of nutrients.
- To learn about various methods of cooking and to understand the selection, nutritional contribution of and effect of cooking on different food groups.
- To describe ways of reducing nutrient losses during cooking.
- To be able to prepare dishes using principles of food science.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Comprehend the relationship between food, nutrition and health.
- Understand the selection, nutritional contribution and changes during cooking of the commonly consumed foods.
- Understand the importance of various nutrients and their dietary sources.
- Develop understanding about the methods of preparing food with better nutrient retention and improving quality of diets.

SYLLABUS OF DSC HP 205

Unit I: Basic Concepts in Food and Nutrition -12 Hours

Basic terminology used in the sciences of food and nutrition and understanding the relationship between what we eat and health.

Subtopics

- Basic terms used in study of food and nutrition
- Understanding relationship between food, nutrition and health

- Functions of food-Physiological, psychological and social

Unit II: Nutrients -12 Hours
Functions, dietary sources and clinical manifestations of deficiency/ excess of the nutrients
Subtopics
- Energy, carbohydrates, lipids and proteins
- Fat soluble vitamins
- Water soluble vitamins
- Minerals

Unit III: Food Groups – 12 Hours
Selection, nutritional contribution and changes during cooking of various food groups.
Subtopics
- Cereals and pulses
- Fruits and vegetables
- Milk & milk products
- Eggs
- Meat, poultry and fish
- Fats and oils

Unit IV: Methods of Cooking and Preventing Nutrient Losses- 09 Hours
Different methods of cooking and how nutrients can be retained
Subtopics
- Dry, moist, frying and microwave cooking
- Advantages, disadvantages and the effect of various methods of cooking on nutrients
- Minimize nutrient losses

Practical -30 Hours

- Weights and measures; preparing market order and table setting
- Food preparation, understanding the principles involved, nutritional quality and portion size

- Cereals: Boiled rice, pulao, chapati, paratha-plain/stuffed, poori, pastas
- Pulses: Whole, dehusked, pulse curry
- Vegetables: Dry preparation, vegetable curry
- Milk preparations: Kheer, porridge, custard
- Egg preparations: Boiled, poached, fried, scrambled, omelettes, egg pudding
- Soups: Plain and cream soups
- Baked products: cakes, biscuits/cookies
- Snacks and Breakfast Cereals: pakoras, cutlets, samosas, cheela, upma/poha, sandwiches
- Salads: salads and salad dressings

Essential Readings

1. Chadha R and Mathur P (eds)(2015). Nutrition: A Lifecycle Approach. Hyderabad: Orient Blackswan.
2. Khanna K, Gupta S, Seth R, Mahna R, Rekhi T (2004). The Art and Science of Cooking: A Practical Manual, Revised Edition. New Delhi: Elite Publishing House Pvt Ltd.
3. Raina U, Kashyap S, Narula V, Thomas S, Suvira, Vir S, Chopra S (2010). Basic Food Preparation: A Complete Manual, Fourth Edition. Hyderabad: Orient Black Swan.
4. Rekhi T and Yadav H (2014). Fundamentals of Food and Nutrition. New Delhi: Elite Publishing House Pvt Ltd.
5. Srilakshmi B (2014). Food Science, 6th Edition. Delhi: New Age International Ltd.

Suggested Readings

1. Bamji MS, Krishnaswamy K, Brahmam GNV (2016). Textbook of Human Nutrition, 4th edition. New Delhi: Oxford and IBH Publishing Co. Pvt. Ltd.
2. Byrd-Bredbenner C, Moe G, Beshgetoor D, Berning J. (2013). Wardlaw's Perspectives in Nutrition, International Edition, 9th edition, New York: McGraw- Hill.
3. Sethi P, Lakra P. Aahar Vigyan, Poshan evam Suraksha (Hindi); First Ed; 2015; Delhi: Elite Publishing House (P) Ltd.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE– 3 (DSC HP 206): Fundamentals of Communication

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course(if any)
		Lecture	Tutorial	Practical/ Practice		
Fundamentals of Communication	4	3	0	1	12th Pass	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To learn about the concept, nature, and scope of communication.
- To understand the process of communication with the help of theories, models, and elements of communication.
- To recognize and appreciate the role of Perception, Empathy, Persuasion, Culture and listening in communication.
- To be able to comprehend the various communication transactions and their role in day-to-day life with special reference to public communication.
- To understand the relationship between culture and communication and its applications in real life settings.

Learning outcomes

The Learning Outcomes of this course are as follows:
The students would be able to:

- Develop a clear understanding of the concepts of human communication.
- Comprehend the elements and models governing the process of effective communication.
- Gain understanding about the related concepts of communication such as Perception, Empathy, Persuasion and Listening
- Understand the various communication transactions as well as the qualities and skills required of an effective public speaker.
- Appreciate the role and application of factors for effective communication.

SYLLABUS OF DSC HP 206

Unit I: Communication: Core Concepts-12 Hours

The Unit explores the fundamentals of Human Communication tracing the history of communication from the olden times to the present times. It highlights the concept, nature, types, scope, and postulates of communication and discusses the functions performed through communication.

Subtopics:

- Historical background, concept, nature, functions, and scope of communication
- Types of Communication – Formal and informal communication; Verbal and Non-verbal communication; Digital and Non-digital communication
- Verbal communication- Principles, types, effective use of verbal messages for communication
- Non-verbal communication- functions, types, skills, channels of non-verbal communication, inter-relationship between culture and non-verbal skills
- Elements of communication - Source, Message, Channel, Receiver, Feedback, Context, Noise & Effects

Unit II: Communication Models and Theories- 09 Hours

The Unit emphasizes the models and theories of the communication process. The further delves on the importance of these models and theories for understanding the effectiveness of communication as a process.

Subtopics:

- Models of Communication: Types of models- Linear, Interaction and Transaction models, (Models by Aristotle, Harold Laswell, Shannon &Weaver, Charles Osgood, Wilbur Schramm, Helical model)
- Theories of Communication: Mass Society, Propaganda, Limited Effects, Individual Difference and Personal Influence

Unit III: Factors for Effective Communication – 12 Hours

The Unit delves with intricate concepts such as Empathy, Persuasion, Perception and Listening that are associated with communication. The unit also discusses the relationship between culture and communication.

- Factors for effective communication: Definitions, goals and principles of Empathy, Perception, and Persuasion
- Empathy: Concept and Theories
- Perception: Concept and Theories
- Listening in Human Communication-Listening process, significance of good listening, styles of listening, barriers to listening, culture and listening, listening theories
- Culture and communication- Relationship between culture and communication, signs, symbols and codes in communication

Unit IV: Communication Transactions and Learning – 12 Hours

The Unit III elucidates upon the various levels of communication transactions. This Unit in particular lays thrust on the Public communication and 'need and importance' of communication for learning. The unit also highlights the concept of communication for development.

Subtopics:

- Levels of communication transactions
- Public communication- Concept, types, techniques and skills in public speaking, qualities of an effective public speaker, overcoming speaker apprehension
- Communication, and Learning: Learning as Communication Process, Domains of Learning. Theories of learning
- Audio-Visual Aids in communication- definitions, functions, classification including Edgar Dale's Cone of Experience
- Communication for Development- Concept and approaches

PRACTICAL – 30 Hours

- Exercises to understand visual communication: Elements of Art and Principles of Design
- Exercises to explore dimensions of non-verbal communication
- Hands on practice with different types of public speaking
- Exercises in effective listening skills
- Exercises on building empathy for effective communication
- Analysis and designing of IEC materials

ESSENTIAL READINGS

Devito, J. (2012). *Human Communication*. New York: Harper & Row.

Barker, L. (1990). *Communication*, New Jersey: Prentice Hall, Inc; 171.

Anand, S. & Kumar, A. (2016). *Dynamics of Human Communication*. New Delhi: Orient Black Swan.

Vivian, J. (1991). *The Media of Mass Communication.* Pearson College Div; 11th edition (19 March 2012).

SUGGESTED READINGS:

Patri, V. R. and Patri, N. (2002). *Essentials of Communication*. Greenspan Publications

Baran, S. (2014). *Mass Communication Theory*. Wadsworth Publishing.

Stevenson, D. (2002). *Understanding Media Studies: Social Theory and Mass Communication*, Sage Publications.

McQuail, D. (2000). *Mass Communication Theories*. London: Sage Publications.

Zeuschner, R. (1997). *Communicating Today*. California State University, USA.

PRACTICAL WORK:

Punhani & Aggarwal (2014). *Media for Effective Communication*. Elite Publishers, New Delhi.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

<u>**BSC. (HONS.) FOOD TECHNOLOGY**</u>

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
PRINCIPLES OF FOOD PROCESSING	4	3	0	1	XII with PCM/PCB	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To understand freezer, dryer types and functioning
- To understand the material handling, separation processes and thermal processing

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand cold preservation, Freezer types and functioning
- Understand Dehydration, Dryer types and functioning
- Understand the material handling in food industry, conveyer types, separation processes by distillation, extraction, filtration
- Understand thermal processing and fundamentals of thermal process calculations

SYLLABUSOF DSC-04

Unit1: Cold Preservation and Freezers (12 Hours)

- Refrigeration and Freezing: requirements of refrigerated storage - controlled low temperature, air circulation and humidity, modified gas atmosphere. Changes in food during refrigerated and frozen storage, Refrigeration load, factors determining freezing rate: food composition and non-compositional.
- Freezing methods -direct and indirect, still air sharp freezer, blast freezer, fluidized freezer, plate freezer, spiral freezer and cryogenic freezing.

Unit2: Dehydration **(12 Hours)**

Changes in food during drying, drying methods and equipments air convection dryer, tray dryer, tunnel dryer, continuous belt dryer , fluidized bed dryer, spray dryer, drum dryer, vacuum dryer, freeze drying ,foam mat drying.

Unit3: Thermal processing **(9 Hours)**

Principles of thermal processing, Thermal resistance of microorganisms, Thermal Death Time, Lethality concept, characterization of heat penetration data, Thermal process Calculations, Aseptic processing of food

Unit4: Material handling and Separation processes (12 Hours)

Elementary concept of material handling in food industry, equipment and functioning of belt conveyor, screw conveyor, bucket elevator and pneumatic conveyor.
Distillation principles and methods: steam, batch, continuous distillation with rectification and stripping.

Extraction : Hildebrandt, Bollman, SCF extraction Filtration : Plate and frame , pressure leaf, continuous rotary vacuum ,batch and continuous filtration

Practical Exercises: 30 Hours

The learners are required to:

- Preservation of food by freezing
- Drying of food using Tray dryer/other dryers
- Preservation of food by canning (Fruit/Vegetable/meat)
- Cut-out analysis of canned food
- Osmotic dehydration
- Minimal Processing
- Perform distillation of any food sample/by product
- Processing of ready to eat frozen products
- Study of Thawing Characteristics of frozen food

Essential/recommended readings

- Potter,N.N.and Hotchkiss,J.H.(2007). Food Science 5th Ed. New York: Chapman & Hall
- Ramaswamy, H. and Marcott, M. (2006). Food Processing Principles and Applications. CRC Press.
- Rao, P.G. (2010). Fundamentals of Food Engineering. New Delhi: PHI Learning Pvt Ltd .
- Desrosier, N.W. and Desrosier, J.N. (1998). The Technology of Food Preservation. New Delhi: CBS Publication.
- Toledo, Romeo T. (2007). Fundamentals of Food Process Engineering. Aspen Publishers.

- **Note: Learners are advised to use the latest edition of readings.**

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DSC 05 : TECHNOLOGY OF FOOD PRESERVATION

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
TECHNOLOGY OF FOOD PRESERVATION	4	3	0	1	XII with PCM/PCB	NIL

Learning Objectives
The Learning Objectives of this course are as follows:
- To learn science behind various preservation/processing technologies.
- Technological application of concepts on conventional Indian foods.

Learning outcomes

The Learning Outcomes of this course are as follows:
- Understanding of the concept of different processing and preservation technologies
- Appreciate significance of various preservation methods used in food industries.

SYLLABUS OF DSC-05

Unit1: Introduction to Technology of Food Preservation (6 Hours)
Introduction to historical evolution to food preservation techniques- Conventional to recent technologies Classification of foods based on pH, concept of shelf life, perishable foods, semi perishable foods, shelf stable foods.

Unit2:Food Preservation by Low temperature (14 Hours)
Introduction to refrigeration, chilling, freezing as a means of preservation, cold storage Principle of freezing, freezing curve, changes occurring during freezing, types of freezing i.e. slow freezing, quick freezing, Introduction to thawing, changes during thawing and its effect on food

Unit3: Food Preservation by Thermal Processing and Irradiation (10 Hours)
Introduction to Thermal Processing- Blanching, pasteurization, sterilization, commercial sterilization. Introduction, units of radiation, concept of cold sterilization, kinds of ionizing radiations, application in food industry.

Unit4: Food Preservation by Moisture control (15 Hours)
Introduction to Drying and Dehydration -Drying as a means of preservation, differences between sun drying and dehydration (i.e. mechanical drying), normal drying curve, heat and mass transfer, factors affecting rate of drying and its application in food industry.
Introduction to Evaporation as a means of preservation – Definition, factors affecting evaporation, and its application in food industry.

Practical Exercises: 30 Hours

The learners are required to:

- To study methods of sampling.
- To study the concept of shelf life of different foods.
- To perform blanching of plant foods.
- To study the concept of sterilization
- To perform pasteurization of fluids- juices/ milk/ squashes etc using different methods.
- To determine the pH of different foods.
- To evaluate the quality characteristics of foods preserved by solar drying/ dehydration/ freezing.

Essential/recommended readings

- Potter, N. N., & Hotchkiss, J. H. (2012). Food Science. Springer Science & Business Media.
- Fellows, P. J. (2009). Food Processing Technology: Principles and Practice. Elsevier.
- Bawa. A.S., Chauhan, O.P, Raju. P.S. (2013) ed. Food Science. New India Publishing agency.
- Stewart, G.F., & Amerine, M.A. (2012). Introduction to Food Science and Technology.Elsevier, 2nd Edition.
- Rao, E.S. (2019) Fundamentals of Food Technology and Preservation, Variety Books, New Delhi.
- Frazier, W.C. & West Hoff, D.C. 2004. Food Microbiology. TMH Publication, New Delhi,.
- Rao, D.G. 2010. Fundamentals of Food Engineering, PHI Learning Pvt Ltd, New Delhi,

- **Note: Learners are advised to use the latest edition of readings.**

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DSC 06 : FRUITS, VEGETABLES & PLANTATION CROPS PROCESSING TECHNOLOGYDSC 04 PRINCIPLES OF FOOD PROCESSING

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
FRUITS, VEGETABLES & PLANTATION CROPS PROCESSING TECHNOLOGY	**4**	**3**	0	**1**	XII with PCM/PCB	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To impart knowledge of different methods of fruits and vegetables processing.
- To learn about processing of various spices, tea, coffee and cocoa.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand the concept of quality of fruits and vegetables for developing good quality end products.
- Understand the processing and preservation of fruits and vegetables using various techniques.
- Understand processing of plantation crops.

SYLLABUS OF DSC-06

Unit1: Introduction to Fruits and Vegetables (6 Hours)

Importance of Fruits & Vegetables
History & need of preservation
Reasons of spoilage, method of preservation (Short & Long Term)
Post harvest physiological & biochemical changes in fruits &vegetables

Unit2: Canning & Dehydration (11 Hours)

Process of canning, factors affecting the process- time and temperature
Containers of packing, lacquering, syrups and brines for canning.
Spoilage in canned foods.
Sun drying & mechanical dehydration
Process variation for fruits and vegetables packing and storage. Case hardening

Unit3:Fruits Beverages & Tomato Products (13 Hours)

Introduction & Processing of fruit juices (selection, juice extraction, deaeration, straining, filtration and clarification)

Preservation of fruit juices (pasteurization, preservation with chemical, sugar & salt, freezing, drying, tetra-packing, carbonation)
Processing of squashes, cordials, nectars, concentrates and powder
Tomato Products : processing of tomato juice, tomato puree, paste, ketchup, sauce and soup

Unit4: Products preserved with class I & class II preservatives (7 Hours)

Processing & Technology of Jam, Jelly, Marmalade & Pickles (Essential constituents, Role of pectin), Theory of jelly formation, defects in jelly,
Marmalade - Types, defects.
Pickles-- Processing , Types, Causes of spoilage in pickling

Unit5: Technology of Plantation Crops (8 Hours)

Spices
Processing and properties of major and minor spices
Essential oils & oleoresins, adulteration Tea, Coffee and Cocoa
Processing, Variety and Products

Practical Exercises: 30 Hours

The learners are required to:

- Estimation of total soluble solids (TSS), pH, acidity of various products.
- Estimation of brix: acidity ratio of various products.
- Estimation of ascorbic acid and effect of heat treatment on it.
- To study the steps of can making process.
- Preparation & evaluation of pectin based product. (Jam)
- Preparation & evaluation of tomato puree.
- Dehydration of fruits and vegetables
- Rehydration of fruits and vegetables
- Extraction & estimation of polyphenols from fruit & Vegetable wastes.

Essential/recommended readings

- Girdharilal., Siddappaa, G.S and Tandon, G.L.(2009). Preservation of fruits & vegetables. ICAR, New Delhi.
- Thompson, A.K., (2003). Fruits and vegetables; Harvesting, handling and storage. Blackwell Publishing.
- Verma L.R. & Joshi VK. 2000. Post Harvest Technology of Fruits & Vegetables. Indus Publication.
- Crusess, W.B. (2004). Commercial Unit and Vegetable Products. W.V. Special Indian Edition. Agrobios India.
- Manay, S. and Shadaksharaswami, M. (2004). Foods: Facts and Principles. New Age Publishers.
- Ranganna S.(2007). Handbook of analysis and quality control for fruits and vegetable products. Tata Mc Graw-Hill publishing company limited, Second edition.
- Srivastava, R.P. and Kumar, S. (2006). Fruits and Vegetables Preservation-Principles and Practices. 3rd Ed. International Book Distributing Co.
- Somogyi, L.P., Ramaswamy, H.S. and Hui, Y.H. (1996). Biology, Principles and Applications. Volume 1. Technomic Publishing Company, Inc.

- **Note: Learners are advised to use the latest edition of readings.**
    - **Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.**

GE 02: CHEMISTRY OF FOOD

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
CHEMISTRY OF FOOD	4	3	0	1	XII with PCM/PCB	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To understand the chemistry of foods - composition of food, role of each component
- To understand the different macromolecules and micro molecules in food
- To understand how food components contribute to overall quality of foods

Learning outcomes

The Learning Outcomes of this course are as follows:

- To understand the chemistry of foods - composition of food
- To understand the role of each component, their properties and reactions in food
- To comprehend how dietary components influence total food quality

SYLLABUS OF GE 02

Unit1: Introduction to chemistry of Food (5 Hours)

Introduction to Food Chemistry

Brief composition of food (Carbohydrates, fats, proteins, vitamins, minerals and pigments)

Unit2: Chemistry of Macromolecules (20 Hours)

Water: Definition of water in food, Structure of water and ice, Types of water, Role of water activity in shelf life and packaging Carbohydrates: Introduction, Classification, and Chemical reactions of carbohydrates Protein: Introduction, classification and structure, types of food protein (meat, egg, milk and wheat)

Lipids: Introduction, classification and structure of triglycerides, types of fatty acid, deterioration of fats and oils. (Autooxidation and lipolysis)

Unit3: Chemistry of Micro molecules (10 Hours)

Vitamins: Introduction, types (water soluble and fat soluble vitamins)

Minerals: Introduction, major and minor minerals, Toxic minerals in food

Unit4: Flavors and Pigments (10 Hours)

Definition and basic tastes

Description of some common food flavors

Introduction and classification of pigments

Practical Exercises: 30 Hours

The learners are required to:

- Preparation of primary and secondary solutions
- Estimation of moisture content
- Determination of gelatinization temperature range (GTR) of different starches
- Determination of effect of additives on GTR of starches
- Estimation of total nitrogen content by Kjeldahl method
- Estimation of fat
- Estimation of total ash and acid insoluble ash
- Estimation of reducing sugar

Essential/recommended readings

- DeMan, John M. (1995). Principles of Food Chemistry. 3rd Ed., Springer.
- Fennema, Owen R. (2008). Fennema's Food Chemistry-CRC Press (2008) - 4th Edition.
- Potter,N.N.and Hotchkiss,J.H.(2007). Food Science 5th Ed. New York: Chapman & Hall.
- Richard Owusu-Apenten. (2002) Introduction to Food Chemistry. CRC press
- Hans-Dieter Belitz, Werner Grosch, Peter Schieberle. (2009) Food Chemistry. Springer link

- **Note: Learners are advised to use the latest edition of readings.**

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

B.A (Prog.) with Nutrition and Health Education (NHE) as Major

Category-II

DISCIPLINE SPECIFIC CORE COURSE – DSC-3-NHE: DIET PLANNING THROUGH THE LIFE SPAN

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Prerequisite of the course
		Lecture	Tutorial	Practical/ Practice		
Diet Planning Through the Life Span	4	3	0	1	Class XII Pass	DSC-1-NHE and DSC-2-NHE

Learning Objectives:

1. To introduce students to the basic concepts of meal planning.
2. To equip them with knowledge of physiological changes, nutritional requirements, nutritional concerns and healthy food choices during the life cycle.

Learning Outcomes:

After completion of the course, the students will be able to:

1. Describe physiological changes and nutritional requirements across the lifespan.
2. Understand the factors affecting meal planning.
3. Understand the importance of food exchange list and use them for meal planning.
4. Plan and prepare balanced meals and nutritious snacks for various age groups.

SYLLABUS OF DSC-3

Theory:

Unit 1: Nutrient Requirements and Recommendations (5 Hours)

- *Unit Description*: This unit will introduce the concept of dietary reference intake.

- *Subtopics:*
  - Nutrient requirement - concept and background
  - Dietary reference intake
  - EAR and RDA
  - Reference man and reference woman

Unit 2: Fundamentals of Menu Planning (6 Hours)

- *Unit Description:* This unit will introduce essential requirements for planning of meals.

- *Subtopics:*
    - Introduction and use of food exchange list
    - Concept and importance of meal planning
    - Factors affecting meal planning

Unit 3: Nutrition during Childhood (16 Hours)

- *Unit Description:* This unit will introduce nutritional requirement, physiological changes, nutritional concerns and healthy eating practices during childhood.
- *Subtopics:*
    - Infancy
    - Preschoolers
    - School- going children
    - Adolescents

Unit 4: Nutrition during Adulthood and Old Age (18 Hours)

- *Unit Description*: This unit will introduce nutritional requirement, physiological changes, nutritional concerns and healthy food choices during adulthood and old age.
- *Subtopics:*
    - Adulthood
    - Pregnancy
    - Lactation
    - Old age

Practical: 30 Hours

Unit 1: Introduction to Meal Planning (10 Hours)

- *Subtopics:*
    - Use of comprehensive food exchange list in meal planning
    - Meal distribution and menu planning
    - Nutrient calculations

Unit 2: Planning and Preparation of Diets/Dishes/Snacks (20 Hours)

- *Subtopics:*
    - Infant- complementary feeding
    - Preschooler child

- School aged child
- Adolescent
- Adult
- Pregnant and lactating woman
- Elderly

Essential/recommended readings:

1. Chadha, R., & Mathur, P. (2015). *Nutrition: A life cycle approach*. Delhi: Orient Blackswan.
2. Sethi, P., & Lakra, P. (2015). *Aahar Vigyan, Poshan Evam Suraksha*. Delhi: Elite Publishing House Pvt. Ltd.
3. Mudambi, S. R., & Rajagopal M. V. (2012). *Fundamentals of food, nutrition and diet therapy* (6^{th} ed.). Delhi: New Age International (P) Ltd.
4. Siddhu, A., Bhatia, N., Singh, K., Gupta, S. (Eds.). (2017). *Lady Irwin College Technical series 6: Compilation of food exchange list.* Delhi: Global books organisation.
5. Puri, S. et al (2020). *Food exchange list- A tool for meal planning.* New Delhi: Elite publishing house.
6. Longvah, T. et al (2017). *Indian food composition tables.* Hyderabad, Telangana: National Institute of Nutrition.

Suggested readings:

1. Wardlow, G. M., & Hampl, J. S. (2019). *Perspectives in nutrition.* (11^{th} ed.). New York, NY: McGraw Hill.
2. Khanna, K. et al. (2013). *Textbook of nutrition and dietetics.* Delhi: Elite Publishing house (P) Ltd.
3. Shubhangini, A., & Joshi, S. (2021). *Nutrition and Dietetics* (5^{th} ed.). McGraw Hill Education (India) Private Limited. ISBN: 978-93-90727-82-7.
4. Edelstein, S., & Sharlin, J. (Eds). (2009). *Life cycle nutrition – an evidence based approach* Burlington, MA: Jones and Barlett Publishers.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – DSC-4-NHE: DIETARY GOALS AND GUIDELINES FOR INDIANS

Credit distribution, Eligibility and Pre-requisites of the Course

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Prerequisite of the course
		Lecture	Tutorial	Practical/ Practice		
Dietary Goals and Guidelines for Indians	4	3	1	0	Class XII Pass	NIL

Learning Objectives:

1. To introduce the concept of nutritionally adequate diets and healthy lifestyles from conception till old age.
2. To equip the students with the knowledge of dietary goals and guidelines for Indians relating to nutritional requirements, deficiency diseases and chronic diet-related disorders.

Learning Outcomes:

After completion of the course, the students will be able to:

1. Describe food groups, food pyramid and the concept of a balanced diet.
2. Understand the physiological changes throughout the lifespan.
3. Acquaint themselves with the dietary goals and dietary guidelines for Indians across the life cycle.

SYLLABUS OF DSC-4

Theory:

Unit 1: Basic Concepts of Food (9 Hours)

- *Unit Description:* This unit will introduce various food groups, concept of balanced diet, food pyramid and other aspects regarding diet.
- *Subtopics:*
  - Food groups: basic classification and nutritional contribution
  - Food pyramid
  - Balanced diet and My food plate
  - Food facts, fads and fallacies

Unit 2: Dietary Guidelines I (15 Hours)

- *Unit Description:* This unit will introduce basic dietary goals for healthy living and dietary guidelines.
- *Subtopics:*
    - Dietary goals
    - Guidelines to ensure nutritional adequacy and prevent deficiency diseases
    - Guidelines related to various stages of life

Unit 3: Dietary Guidelines II (13 Hours)

- *Unit Description:* This unit will introduce dietary guidelines to deal with health concerns and healthy food practices.
- *Subtopics:*
    - Guidelines to maintain an ideal body weight and prevent chronic diet-related disorders
    - Guidelines regarding food-related practices

Unit 4: Practical Application of Dietary Guidelines (8 Hours)

- *Unit Description:* This unit will introduce practical aspects with suitable examples to attain all dietary guidelines for Indians.
- *Subtopics:*
  Sample eating patterns/ menus for the following meals/ snacks:
    - Breakfast
    - Lunch/packed lunch
    - Dinner
    - Snacks

Essential/recommended readings:

1. Damyanthi, K. et al. (2011). *Dietary guidelines for Indians- A manual.* (2nd ed.) Hyderabad. National Institute of Nutrition.
2. Chadha, R., & Mathur, P. (2015). *Nutrition: A life cycle approach*. Delhi: Orient Blackswan.
3. Agarwal, A., & Udipi. S. (2014). *Textbook of human nutrition*, Jaypee Brothers Medical Publishers (P) Ltd, New Delhi.
4. Sethi, P., & Lakra, P. (2015). *Aahar Vigyan, Poshan Evam Suraksha*. Delhi: Elite Publishing House Pvt. Ltd.

Suggested readings:

1. Mudambi, S. R., & Rajagopal M. V. (2012). *Fundamentals of food, nutrition and diet therapy* (6th ed.). Delhi: New Age International (P) Ltd.
2. Wardlow, G. M., & Hampl, J. S. (2019). *Perspectives in nutrition.* (11th ed.). New York, NY: McGraw Hill.
3. Shubhangini, A., & Joshi, S. (2021). *Nutrition and Dietetics* (5th ed.). McGraw Hill Education (India) Private Limited. ISBN: 978-93-90727-82-7.
4. Khanna, K. et al. (2013). *Textbook of nutrition and dietetics.* Delhi: Elite Publishing house (P) Ltd.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

B.A (Prog.) with Nutrition and Health Education (NHE) as Non-Major

Category-III

DISCIPLINE SPECIFIC CORE COURSE – DSC-4-NHE: DIETARY GOALS AND GUIDELINES FOR INDIANS

Credit distribution, Eligibility and Pre-requisites of the Course

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Prerequisite of the course
		Lecture	Tutorial	Practical/ Practice		
Dietary Goals and Guidelines for Indians	4	3	1	0	Class XII Pass	NIL

Learning Objectives:

1. To introduce the concept of nutritionally adequate diets and healthy lifestyles from conception till old age.
2. To equip the students with the knowledge of dietary goals and guidelines for Indians relating to nutritional requirements, deficiency diseases and chronic diet-related disorders.

Learning Outcomes:

After completion of the course, the students will be able to:

1. Describe food groups, food pyramid and the concept of a balanced diet.
2. Understand the physiological changes throughout the lifespan.
3. Acquaint themselves with the dietary goals and dietary guidelines for Indians across the life cycle.

SYLLABUS OF DSC-2

Theory:

Unit 1: Basic Concepts of Food (9 Hours)

- *Unit Description:* This unit will introduce various food groups, concept of balanced diet, food pyramid and other aspects regarding diet.
- *Subtopics:*
    - Food groups: basic classification and nutritional contribution

- Food pyramid
- Balanced diet and My food plate
- Food facts, fads and fallacies

Unit 2: Dietary Guidelines I (15 Hours)

- *Unit Description:* This unit will introduce basic dietary goals for healthy living and dietary guidelines.
- *Subtopics:*
  - Dietary goals
  - Guidelines to ensure nutritional adequacy and prevent deficiency diseases
  - Guidelines related to various stages of life

Unit 3: Dietary Guidelines II (13 Hours)

- *Unit Description:* This unit will introduce dietary guidelines to deal with health concerns and healthy food practices.
- *Subtopics:*
  - Guidelines to maintain an ideal body weight and prevent chronic diet-related disorders
  - Guidelines regarding food-related practices

Unit 4: Practical Application of Dietary Guidelines (8 Hours)

- *Unit Description:* This unit will introduce practical aspects with suitable examples to attain all dietary guidelines for Indians.
- *Subtopics:*
  Sample eating patterns/ menus for the following meals/ snacks:
  - Breakfast
  - Lunch/packed lunch
  - Dinner
  - Snacks

Essential/recommended readings:

1. Damyanthi, K. et al. (2011). *Dietary guidelines for Indians- A manual.* (2nd ed.) Hyderabad. National Institute of Nutrition.
2. Chadha, R., & Mathur, P. (2015). *Nutrition: A life cycle approach*. Delhi: Orient Blackswan.
3. Agarwal, A., & Udipi. S. (2014). *Textbook of human nutrition*, Jaypee Brothers Medical Publishers (P) Ltd, New Delhi.

4. Sethi, P., & Lakra, P. (2015). *Aahar Vigyan, Poshan Evam Suraksha*. Delhi: Elite Publishing House Pvt. Ltd.

Suggested readings:

1. Mudambi, S. R., & Rajagopal M. V. (2012). *Fundamentals of food, nutrition and diet therapy* (6th ed.). Delhi: New Age International (P) Ltd.
2. Wardlow, G. M., & Hampl, J. S. (2019). *Perspectives in nutrition.* (11th ed.). New York, NY: McGraw Hill.
3. Shubhangini, A., & Joshi, S. (2021). *Nutrition and Dietetics* (5th ed.). McGraw Hill Education (India) Private Limited. ISBN: 978-93-90727-82-7.
4. Khanna, K. et al. (2013). *Textbook of nutrition and dietetics.* Delhi: Elite Publishing house (P) Ltd.

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CATEGORY-II
B.A (Prog.) with Human Development and Family Empowerment (HDFE) as Major

DISCIPLINE SPECIFIC CORE COURSE – DSC-3-HDFE: ADULTHOOD AND AGEING THROUGH A LIFE SPAN PERSPECTIVE

Credit distribution, Eligibility and Pre-requisite of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (If any)
		Lecture	Tutorial	Practical/ Practice		
Adulthood and Ageing through a Lifespan perspective	**4**	**2**	0	**2**	Class XII Pass	DSC-1-HDFE and DSC-2-HDFE (both as Major)

Learning Objectives:

1. To understand the developmental patterns in early, middle and late adulthood.
2. To understand the needs and challenges of the older adults.
3. To use research tools to investigate the ageing process and develop critical thinking skills, necessary to do research in the field of ageing.

Learning Outcomes:

After completion of the course, the students will be able to:

1. Understand the characteristics of Adulthood and old age.
2. Understand the challenges of adulthood and ageing and the coping strategies.
3. Students will develop awareness about the developmental patterns in adulthood.
4. Sensitizing students towards the concerns of adulthood and ageing.

THEORY
(Credits:2, Periods: 30)

Unit 1: Adulthood and Ageing (10 hours)

- *Unit Description*: This unit will introduce the concept of adulthood and ageing
- *Subtopics:*
  - Understand definition
  - Concept and scope of ageing as a field of study

- Theoretical perspectives on ageing
- Developmental Tasks of Adulthood

Unit 2: Early & Middle Adulthood (10 hours)

- *Unit Description*: This unit will introduce the concept of early and middle adulthood.
- *Subtopics:*
    - Characteristics
    - Developmental milestones - Physical, cognitive, social and emotional development

Unit 3: Late Adulthood (10 hours)

- *Unit Description*: This unit will introduce the concept of Late adulthood.

- *Subtopics:*
    - Definition
    - Characteristics
    - Developmental milestones
    - Physical changes in males and females
    - Psychological implications of physical changes. Social – Emotional Development. Cognitive Development

PRACTICAL
(Credits: 2, Periods: 60)

- **Unit 1: Conduct Case profile of a senior citizen (30 hours)**
- **Unit 2: Visit to a senior citizen home and /or Movie review (30 hours)**

Essential / recommended readings:

1. Berk, L. E. (2017). *Development through the lifespan* (7rd edition). US: Pearson Education.
2. Rice, F.P. (1998). *Human Development: A Life-span Approach* (3rd edition). US: Prentice Hall.
3. Santrock, J. W. (2011). *Life-span development* (13th ed.). McGraw-Hill Education.
4. Verma, P., Srivastava D. N. and Singh, A. (1996). *Bal manovigyan and bal vikas*. Agra: Agrawal Publication

Suggested Readings:

1. Patrick, J.H., Hayslip Jr. B., Sawyer, L.H. (2000). *Adult Development and aging: Growth, longevity and challenges* (1st edition). Sage Publications
2. Singh, A. (2015). *Foundation of Human development: A lifespan approach*. Hyderabad: Orient Blackswan Pvt.
3. Singh, V. (2007). *Bal vikas avam bal manovigyan*. Jaipur: Panchsheel Prakashan

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – DSC-4-HDFE: INTRODUCTION TO HUMAN DEVELOPMENT

Credit distribution, Eligibility and Pre-requisite of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Introduction to Human Development	**4**	**2**	0	**2**	Class XII Pass	DSC-1-HDFE and DSC-2-HDFE (both as Major)

Learning Objectives:

1. To create an understanding of various stages of lifespan development.
2. To understand developmental changes occurring during infancy, childhood, adolescence.
3. To understand the conflicts during various stages of lifespan development and ways to deal with it.

Learning Outcomes:

After completion of the course, the students will be able to:

1. Understand developmental changes occurring during the lifespan with respect to infancy, childhood, adolescence
2. Understand various stages of lifespan development with respect to conflicts and ways to deal with it.
3. Learn the basic skills of research and documentation and apply the knowledge of methods of data collection in real life situations.

THEORY

(Credits: 2; Periods: 30)

Unit 1: Development in early years: The new-born and stage of infancy (10 Hours)

- *Unit Description:* This unit will discuss about the development in early years
- *Subtopics:*
    - New-born: Characteristics.
    - Reflexes
    - Infant developmental milestones

Unit 2: Childhood- Early & Middle (10 Hours)

- *Unit Description:* This unit will introduce all domains of development with regard to early and middle childhood period.
- *Subtopics:*
  - o Physical Development.
  - o Socio-emotional Development.
  - o Cognitive and Language Development

Unit 3: Adolescence (10 Hours)

- *Unit Description:* This unit will introduce regarding adolescent age group
- *Subtopics:*
  - o Definition.
  - o Characteristics.
  - o Developmental milestones.
  - o Physical changes in males and females.
  - o Psychological implications of physical changes.
  - o Social – Emotional Development.
  - o Cognitive Development.

PRACTICAL
(Credit: 2, Periods: 60)

Unit 1: Understand Methods and techniques of child study. (15 hours)

Unit 2: Conduct any 2 interviews. (30 hours)

Unit 3: Conduct any 1 observation. (15 hours)

Essential / recommended readings:

1. Bee, H. L (2011). *The developing child*. London: Pearson.
2. Berk, L. E. (2017). *Development through the lifespan* (7rd edition). US: Pearson Education.
3. Santrock, J. W. (1996). *Child development*. New York: Tata McGraw Hill
4. Verma, P., Srivastava D. N. and Singh, A. (1996). *Bal manovigyan and bal vikas*. Agra: Agrawal Publication.

Suugested readings:

1. Papilla, D.E., Olds, S. W. and Feldman, R. D (2004). *Human development*. New York: Mcgraw Hill.
2. Singh, A. (2015). *Foundation of Human development: A lifespan approach*. London: Orient Longman.

3. Singh, V. (2007). *Bal vikas avam bal manovigyan*. Jaipur: Panchsheel Prakashan.
4. Sapra, R. (2007). *Manav vikas: Ek parichaya*. New Delhi: Vishwa Bharti Publications. Chapter 1, pg 1-6

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

CATEGORY-III

B.A (Prog.) with Human Development and Family Empowerment (HDFE) as Non-Major

DISCIPLINE SPECIFIC CORE COURSE – DSC-4-HDFE: INTRODUCTION TO HUMAN DEVELOPMENT

Credit distribution, Eligibility and Pre-requisite of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Introduction to Human Development	**4**	**2**	0	**2**	Class XII Pass	DSC-2-HDFE (Non-Major)

Learning Objectives:

1. To create an understanding of various stages of lifespan development.
2. To understand developmental changes occurring during infancy, childhood, adolescence.
3. To understand the conflicts during various stages of lifespan development and ways to deal with it.

Learning Outcomes:

After completion of the course, the students will be able to:

1. Understand developmental changes occurring during the lifespan with respect to infancy, childhood, adolescence
2. Understand various stages of lifespan development with respect to conflicts and ways to deal with it.
3. Learn the basic skills of research and documentation and apply the knowledge of methods of data collection in real life situations.

THEORY
(Credits: 2; Periods: 30)

Unit 1: Development in early years: The new-born and stage of infancy (10 Hours)

- *Unit Description:* This unit will discuss about the development in early years
- *Subtopics:*
    - New-born: Characteristics.
    - Reflexes
    - Infant developmental milestones

Unit 2: Childhood- Early & Middle (10 Hours)

- *Unit Description:* This unit will introduce all domains of development with regard to early and middle childhood period.
- *Subtopics:*
  - Physical Development.
  - Socio-emotional Development.
  - Cognitive and Language Development

Unit 3: Adolescence (10 Hours)

- *Unit Description:* This unit will introduce regarding adolescent age group
- *Subtopics:*
  - Definition.
  - Characteristics.
  - Developmental milestones.
  - Physical changes in males and females.
  - Psychological implications of physical changes.
  - Social – Emotional Development.
  - Cognitive Development.

PRACTICAL
(Credit: 2, Periods:60)

Unit 1: Understand Methods and techniques of child study. (15 hours)

Unit 2: Conduct any 2 interviews. (30 hours)

Unit 3: Conduct any 1 observation. (15 hours)

Essential / recommended readings:

1. Bee, H. L (2011). *The developing child*. London: Pearson.
2. Berk, L. E. (2017). *Development through the lifespan* (7rd edition). US: Pearson Education.
3. Santrock, J. W. (1996). *Child development*. New York: Tata McGraw Hill
4. Verma, P., Srivastava D. N. and Singh, A. (1996). *Bal manovigyan and bal vikas*. Agra: Agrawal Publication.

Suugested readings:

1. Papilla, D.E., Olds, S. W. and Feldman, R. D (2004). *Human development*. New York: Mcgraw Hill.
2. Singh, A. (2015). *Foundation of Human development: A lifespan approach*. London: Orient Longman.
3. Singh, V. (2007). *Bal vikas avam bal manovigyan*. Jaipur: Panchsheel Prakashan.

4. Sapra, R. (2007). *Manav vikas: Ek parichaya*. New Delhi: Vishwa Bharti Publications. Chapter 1, pg 1-6

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

Category-II

B.A (Prog.) with Apparel Design and Construction (ADC) as Major

DISCIPLINE SPECIFIC CORE COURSE – DSC-3-ADC: GARMENT DETAILING

Credit Distribution, Eligibility and Pre-requisites of the Course

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Prerequisite of the course
		Lecture	Tutorial	Practical/ Practice		
Garment Detailing	4	2	0	2	Class XII Pass	DSC-1-ADC and DSC-2-ADC

Learning Objectives:

1. To impart basic knowledge required for layout planning on fabrics requiring special attention
2. To familiarise the students about the concepts related to the handling of special fabrics
3. To create an understanding of designing clothes for people with special needs.
4. To develop pattern making and construction skills for various garments and their components
5. To impart skills for developing design variations through dart manipulations

Learning Outcomes:

After completion of the course, the students will be able to:

1. Plan pattern layout on fabrics with special requirements
2. Calculate the fabric requirement per garment
3. Make use of different marker making methods
4. Use design variations of garment components in garment construction
5. Carry out dart manipulation according to design variations
6. Handle special fabrics during pattern layout and sewing
7. Design clothes for people with special needs

SYLLABUS OF DSC-3

Theory:

Unit 1: Layout planning **(8 Hours)**

- *Unit Description:* This unit deals with planning on special fabrics, assessing fabric requirement per garment and marker making.

- *Sub Topics:*
  - Pattern Layouts on special fabrics- unidirectional, bold and large prints, stripes and checks, border design, irregular design fabric, napped fabric
  - Calculation of material requirement for garment construction
  - Marker Making – Factors influencing marker making, Methods of marker making.

Unit 2: Design variations in Garment Components (12 Hours)

- *Unit Description:* This unit focuses on the study of garment components and their design variations. It also covers dart manipulation and creating design variations.

- *Sub Topics:*
  - Study of Garment components – terms, types and Styles, evaluation criteria – Necklines, Collars, Sleeves, Cuff, Yokes, Pockets, Plackets
  - Design variations in bodice, skirts, silhouettes, trousers
  - Dart manipulation: Definition, Principles, Methods, dart equivalents

Unit 3: Handling of Special Fabrics (10 Hours)

- *Unit Description:* This unit provides the basic knowledge relating to special fabrics and their handling. It also deals with the concepts and requirements of self-help garments and maternity wear.

- *Sub Topics:*
  - Definition and features of Special fabrics
  - Handling of fabrics with reference to designing, layout, marking, cutting, stitching, needle sizes, stitch sizes, threads used, seams and other special considerations – Sheer and slippery fabrics, napped and pile fabrics, lace, silk & crepe, velvet, wool, knits, plaids and stripes. Preparation of a sample file.
  - Garment designing for special needs: basic principles and design requirements – Self-help, maternity wear

Practical:

Unit 1: Basic Blocks and Dart Manipulation (20 Hours)

- *Sub Topics:*
  - Dart manipulation techniques - Single and double dart series, style lines, Yokes, adding fullness
  - Hip length/ Torso Draft
  - Trousers Block
  - Men's Bodice Block

Unit 2: Construction of Garments and their Components (40 Hours)

- *Sub Topics:*

- Preparation of Samples of any three styles of Sleeves
- Preparation of Samples of any three styles of Collars
- Preparation of Samples of any three styles of pockets
- Preparation of Samples of Plackets - continuous bound, even hem, zipper, tailored placket
- Designing and stitching of one upper and one lower garment

Essential/ Recommended Readings:

1. Armstrong, H.J., (2009), Pattern Making for Fashion Design, Harper Collins Publishers Inc., New York.
2. Liechty, E.G., Potterberg, D.N., Rasband, J.A., (2010), Fitting and Pattern Alteration: A Multimethod Approach, Fairchild Publications, New York
3. Macdonald Nora M., (2009), Principles of Flat-Pattern Design, Fairchild Books, New York.
4. Shaeffer Claire, (2003), Sew any Fabric, Krause Publications

Suggested Readings:

1. Brown, P. and Rice, J., (1998), Ready-to-wear Apparel Analysis, Prentice Hall
2. Kallal, M. J., (1985), Clothing Construction, Macmillion Publishing Company, New York
3. Mansfield, E. A. & Lucas, E. L., (1974), Clothing Construction, Houghton Mifflin
4. Stamper, A.A., S. H. Sharp and L.B. Donnell, (1986), Evaluating Apparel Quality, Fairchild Publications, US

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – DSC-4-ADC:
BASIC PATTERN MAKING AND CLOTHING CONSTRUCTION

Credit Distribution, Eligibility and Pre-requisites of the Course

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Prerequisite of the course
		Lecture	Tutorial	Practical/ Practice		
Basic Pattern Making and Clothing Construction	4	2	0	2	Class XII Pass	Nil

Learning Objectives:

1. To introduce students to basic concepts of Body measurements and pattern making
2. To equip the students with the knowledge of pattern layout, fabric cutting, garment sewing and assessing fit in a garment.

Learning Outcomes:

After completion of the course, the students will be able to:

1. Take measurements from body and garments accurately.
2. Create patterns of simple women's clothes and apply the pattern information correctly.
3. Operate a sewing machine for simple sewing tasks using the correct thread, needle and stitch length for various fabrics.
4. Use various types of seams and seam techniques during garment construction
5. Apply concept of fit, evaluate garment fit and do pattern alterations as necessary.

SYLLABUS OF DSC-4

Theory:

Unit 1: Body Measurements and Pattern Making (10 Hours)

- *Unit Description:* This unit introduces the students to the process of taking measurements from body or garment and developing basic blocks for creating garment patterns. It also provides an understanding of the different types of patterns as well as using the symbols and markings mentioned on a pattern correctly.

- *Sub Topics:*
    - Importance of Body measurements, Body Landmarks, Correct procedure of taking body measurements, size charts, Taking measurements from Garments
    - Garment Ease - type and amount in different garments

- Basic Blocks and their importance
- Methods of pattern development: Drafting, Flat pattern making, Draping
- Types of paper pattern - Commercial pattern, Graded pattern, Production pattern
- Pattern information and marking symbols and their importance

Unit 2: Sewing Machines (8 Hours)

- *Unit Description:* This unit provides the essential knowledge required for operating and maintaining a sewing machine for garment construction.

- *Sub Topics:*
  - Classification of Sewing machines
  - Components of a Basic Sewing machine and their functions
  - Introduction to Industrial sewing machines- single needle lock stitch, overlock, blind stitching, button hole and button stitching, bartacking
  - Sewing defects and remedies
  - Care and maintenance of a sewing machine, precautions while working on a sewing machine
  - Selection of threads, needles and stitch length for various fabrics

Unit 3: Sewing Techniques and Garment Fit (12 Hours)

- *Unit Description:* This unit imparts knowledge of seam categories and seam techniques. It also deals with the concept of garment fit and correcting fitting problems through pattern alteration.

- *Sub Topics:*
  - Garment Support Fabrics (Lining, Underlining, Interlining, Interfacing) – their use and selection
  - Basic seam categories- super imposed seam, lapped seam, bound seam, flat seam, decorative seam, ridge seam
  - Additional seam techniques: clipping, notching, grading, trimming, easing, under stitching, stay stitching, trimming a corner
  - Finishing of straight & curved edges- self finish, crossway strips, bias facing, bias binding, shaped facing, self-finishing, casings and finishing with trims
  - Elements of Fit: line, ease, grain, set and balance
  - Fit evaluation, Common fitting problems and pattern correction

Practical: 60 Hours

Unit 1: Development of Basic Blocks and design variations (20 Hours)

- *Subtopics:*
  - Adult women's bodice block, sleeve block, skirt block
  - Developing design variations in adult skirt- A-line, flared, wrap-around, pleated, skirt with yoke

Unit 2: Seams and Garment Construction (40 Hours)

- *Subtopics:*

- Samples of Seams – Plain Seam, French seam, Run-n-fell seam, Lapped seam, Top stitching, Bound/Piped seam, Slot seam, Curved and Corner seam
- Necklines and their finishing: bias facing, bias binding, shaped facing
- Adaptation of basic blocks to construct Saree blouse, Kurti/Kameez, Skirt
- Construction of lower garments: Salwar/ Churidar, Palazzo

Essential Readings:

1. Armstrong, H.J., (2009), Pattern Making for Fashion Design, Harper Collins Publishers Inc., New York.
2. Brown, P. and Rice, J., (1998), Ready-to-wear Apparel Analysis, Prentice Hall
3. Colton V. (1995). Reader's Digest- Complete Guide to Sewing. New York: The Reader's Digest Association, Inc.
4. Knowles A. (2006). Patternmaking for Fashion Designers. New York: Fairchild Publications Inc.
5. Liechty, E.G., Potterberg, D.N., Rasband, J.A., (2010), Fitting and Pattern Alteration: A Multimethod Approach, Fairchild Publications, New York

Suggested Readings:

1. Kallal, M. J., (1985), Clothing Construction, Macmillion Publishing Company, New York
2. Kindersley D. (1996). The Complete Book of Sewing. London: Dorling Kindersley Limited.
3. MacDonald M. (2009). Principles of Flat Pattern Design (4th Edition). New York: Fairchild Publications Inc
4. Stamper, A.A., S. H. Sharp and L.B. Donnell, (1986), Evaluating Apparel Quality, Fairchild Publications, America

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

Category-III

B.A (Prog.) with Apparel Design and Construction (ADC) as Non-Major

DISCIPLINE SPECIFIC CORE COURSE – DSC-4-ADC: BASIC PATTERN MAKING AND CLOTHING CONSTRUCTION

Credit Distribution, Eligibility and Pre-requisites of the Course

Course Title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Prerequisite of the course
		Lecture	Tutorial	Practical/ Practice		
Basic Pattern Making and Clothing Construction	4	2	0	2	Class XII Pass	NIL

Learning Objectives:

1. To introduce students to basic concepts of Body measurements and pattern making
2. To equip the students with the knowledge of pattern layout, fabric cutting, garment sewing and assessing fit in a garment.

Learning Outcomes:

After completion of the course, the students will be able to:

1. Take measurements from body and garments accurately.
2. Create patterns of simple women's clothes and apply the pattern information correctly.
3. Operate a sewing machine for simple sewing tasks using the correct thread, needle and stitch length for various fabrics.
4. Use various types of seams and seam techniques during garment construction
5. Apply concept of fit, evaluate garment fit and do pattern alterations as necessary.

SYLLABUS OF DSC-2

Theory:

Unit 1: Body Measurements and Pattern Making **(10 Hours)**

- *Unit Description:* This unit introduces the students to the process of taking measurements from body or garment and developing basic blocks for creating garment patterns. It also provides an understanding of the different types of patterns as well as using the symbols and markings mentioned on a pattern correctly.

- *Sub Topics:*
    - o Importance of Body measurements, Body Landmarks, Correct procedure of taking body measurements, size charts, Taking measurements from Garments
    - o Garment Ease - type and amount in different garments
    - o Basic Blocks and their importance
    - o Methods of pattern development: Drafting, Flat pattern making, Draping
    - o Types of paper pattern - Commercial pattern, Graded pattern, Production pattern
    - o Pattern information and marking symbols and their importance

Unit 2: Sewing Machines (8 Hours)

- *Unit Description:* This unit provides the essential knowledge required for operating and maintaining a sewing machine for garment construction.

- *Sub Topics:*
    - o Classification of Sewing machines
    - o Components of a Basic Sewing machine and their functions
    - o Introduction to Industrial sewing machines- single needle lock stitch, overlock, blind stitching, button hole and button stitching, bartacking
    - o Sewing defects and remedies
    - o Care and maintenance of a sewing machine, precautions while working on a sewing machine
    - o Selection of threads, needles and stitch length for various fabrics

Unit 3: Sewing Techniques and Garment Fit (12 Hours)

- *Unit Description:* This unit imparts knowledge of seam categories and seam techniques. It also deals with the concept of garment fit and correcting fitting problems through pattern alteration.
- *Sub Topics:*
    - o Garment Support Fabrics (Lining, Underlining, Interlining, Interfacing) – their use and selection
    - o Basic seam categories- super imposed seam, lapped seam, bound seam, flat seam, decorative seam, ridge seam
    - o Additional seam techniques: clipping, notching, grading, trimming, easing, under stitching, stay stitching, trimming a corner
    - o Finishing of straight & curved edges- self finish, crossway strips, bias facing, bias binding, shaped facing, self-finishing, casings and finishing with trims
    - o Elements of Fit: line, ease, grain, set and balance
    - o Fit evaluation, Common fitting problems and pattern correction

Practical: 60 Hours

Unit 1: Development of Basic Blocks and design variations (20 Hours)

- *Subtopics:*
    - o Adult women's bodice block, sleeve block, skirt block

- Developing design variations in adult skirt- A-line, flared, wrap-around, pleated, skirt with yoke

Unit 2: Seams and Garment Construction **(40 Hours)**

- *Subtopics:*
  - Samples of Seams – Plain Seam, French seam, Run-n-fell seam, Lapped seam, Top stitching, Bound/Piped seam, Slot seam, Curved and Corner seam
  - Necklines and their finishing: bias facing, bias binding, shaped facing
  - Adaptation of basic blocks to construct Saree blouse, Kurti/Kameez, Skirt
  - Construction of lower garments: Salwar/ Churidar, Palazzo

Essential Readings:

1. Armstrong, H.J., (2009), Pattern Making for Fashion Design, Harper Collins Publishers Inc., New York.
2. Brown, P. and Rice, J., (1998), Ready-to-wear Apparel Analysis, Prentice Hall
3. Colton V. (1995). Reader's Digest- Complete Guide to Sewing. New York: The Reader's Digest Association, Inc.
4. Knowles A. (2006). Patternmaking for Fashion Designers. New York: Fairchild Publications Inc.
5. Liechty, E.G., Potterberg, D.N., Rasband, J.A., (2010), Fitting and Pattern Alteration: A Multimethod Approach, Fairchild Publications, New York

Suggested Readings:

1. Kallal, M. J., (1985), Clothing Construction, Macmillion Publishing Company, New York
2. Kindersley D. (1996). The Complete Book of Sewing. London: Dorling Kindersley Limited.
3. MacDonald M. (2009). Principles of Flat Pattern Design (4th Edition). New York: Fairchild Publications Inc
4. Stamper, A.A., S. H. Sharp and L.B. Donnell, (1986), Evaluating Apparel Quality, Fairchild Publications, America

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Category-II

B.A. (Prog.) with Food Technology (FT) as Major

DISCIPLINE SPECIFIC CORE COURSE – DSC-3-FT: NUTRITION AND WELL BEING FOR LIFESPAN

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Nutrition and Well Being for Lifespan	4	3	0	1	Class XII Pass	DSC-1-FT

LEARNING OBJECTIVES:

1. To make students understand the concept of wellbeing, good health, dietary guidelines and lifestyle management.
2. To familiarize students with the salient physiological changes and nutrition related health concerns during various stages of lifespan.
3. To familiarize students with the dietary guidelines and lifestyle practices which would support overall wellbeing and good health
4. Make students plan and prepare nutritious meals for self, family and the community.

LEARNING OUTCOMES:

After completion of the course, the students will be able to:

1. Appreciate the role of dietary guidelines and lifestyle management in promoting health and well being
2. Adopt a healthy and active lifestyle suitable to each physiological stage in lifespan
3. Enhance ability to make healthy food choices for self, family and the community
4. Develop educational aids to impart nutrition knowledge.

SYLLABUS OF DSC-3-FT

THEORY:

UNIT I: Maternal and Infant Nutrition **(12 Hours)**

- *Unit Description:* This unit will focus on basic concepts of wellbeing, dietary guidelines as well as maternal and infant nutrition.

- *Subtopics:*
    - Basic concepts: well-being, nutritional status, dietary guidelines and lifestyle management
    - Pregnancy - physiological changes during pregnancy, dietary guidelines, the role of nutrition in the developmental origins of disease
    - Lactation - factors affecting nutritional requirements, dietary guidelines, breast feeding practices
    - Infancy - growth and development, growth monitoring, dietary guidelines (advantages of mother's milk, complimentary feeding)

UNIT II: Child and Adolescent Nutrition (12 Hours)

- *Unit Description:* This unit will focus on dietary guidelines and lifestyle management of children and adolescents.
- *Subtopics:*
    - Childhood Years: growth and development, dietary guidelines during early, middle and late childhood years, common nutrition concerns.
    - Adolescence: growth and development, eating behaviour, dietary guidelines, common health problems during adolescence, eating disorders, lifestyle management.

UNIT III: Nutrition during Adulthood (12 Hours)

- *Unit Description:* This unit will focus and reference man as well as woman and nutritional needs of adults.
- *Subtopics:*
    - Reference Man and Reference Woman, dietary guidelines, role of nutrition in adulthood in the prevention and development of chronic diseases
    - Lifestyle management: healthy eating behaviour, physical activity, stress management, sleep pattern.

Unit IV: Nutrition for the Elderly (9 Hours)

- *Unit Description:* This unit will focus on nutritional needs, lifestyle management, longevity and care for elderly.
- *Subtopics:*
    - Introduction to Geriatrics, physiological changes, nutrition and longevity, nutritional concerns, dietary guidelines, Nutrition and chronic Degenerative Diseases, Nutrient-Drug Interactions (basic concept).

PRACTICAL: 30 Hours

No. of Students per Practical Class Group: 10-15

1. Develop a poster/chart on dietary guidelines or lifestyle management for adults (sedentary, moderate, heavy workers) or pregnant woman. (4 Hours)
2. Develop a digital educational aid on importance of colostrum/mother's milk/food behaviour/lifestyle management (2 Hours)
3. Develop a questionnaire on common nutrition/health concerns (2 Hours)
4. Learn to fill growth chart for under five years children (case study) (2 Hours)
5. Plan and prepare nutritious snack for Pregnant women (iron and folic acid rich) (2 Hours)
6. Plan and prepare nutritious snack Lactating mother (protein and calcium rich) (2 Hours)
7. Plan and prepare nutritious snack Pre-schooler (Vitamin A rich) (2 Hours)
8. Plan and prepare nutritious tiffin for School going child (energy and protein rich) (2 Hours)
9. Plan and prepare nutritious snack for adolescents (energy and protein rich) (2 Hours)
10. Plan and prepare nutritious snack for Elderly (easy to prepare, protein and micro-nutrient rich) (2 Hours)
11. Plan and prepare premix or complimentary food for infants (2 Hours)
12. Plan and organize a health awareness activity in college for college students (exhibition of model snacks/tiffins/one dish 2meals) OR Plan and play a skit on the concept of longevity for elderly in a nearby slum or community center or college event (Group activity) (6 Hours)

ESSENTIAL/ RECOMMENDED READINGS (Theory and Practical):

1. Chadha, R., & Mathur, P. (Eds.). (2015). Textbook Nutrition: A Lifecycle Approach. Orient Blackswan. ISBN978-8125059301
2. Khanna, K., Gupta, S., Passi, S. J., Seth, R., Mahna, R., & Puri, S. (2013). Textbook of Nutrition and -Dietetics (2nd ed.). Elite Publishing House Pvt. Ltd. ISBN: 978-81- 88901-53-1
3. Srilakshmi, B. (2006). Dietetics. New Age International (P) Limited Publishers. ISBN 81-224-1611-X
4. Wardlaw, G. M., & Smith, A. M. (2015). Contemporary Nutrition (9th ed.). McGraw Hill Education (India) Private Limited.

SUGGESTED READINGS:

1. Evans, S. (2009). Nutrition: A Lifespan Approach, Wiley-Blackwell. ISBN:978-1-405- 17878-5.
2. Shubhangini A Joshi, S. (2021). Nutrition and Dietetics (5th ed.). McGraw Hill Education (India) Private Limited. ISBN:978-93-90727-82-7.
3. Bernstein, M. & McMahon, K. (2018). Nutrition Across Life Stages, Jones & Bartlett Publishers. ISBN: 9781284102161
4. Katz, D., Yeh, M. and Levitt, J. (2022). Wolters Kluwer Publishers. ISBN: 9781975161491

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – DSC-4-FT: FOOD SCIENCE PART-II

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Food Science Part-II	4	3	0	1	Class XII Pass	DSC-2-FT

-

LEARNING OBJECTIVES:

1. To familiarize the students with the composition and processing of milk, egg, sugars, fats and miscellaneous food.
2. To impart concept of properties of fats and oil, sugar, egg foam stages and emulsions.

LEARNING OUTCOMES:

After completion of the course, the students will be able to:

1. Describe the composition and nutritive value of milk, egg, sugar and fats and their role in food processing.
2. Develop understanding about basic processing of milk and eggs.
3. Illustrate the behaviour of sugar at various temperatures.
4. Describe spoilage of fat scientifically, determine the smoke point of different fats and illustrate the ways to prevent rancidity of fats.

THEORY:

UNIT I: MILK (9 Hours)

- *Unit Description:* This unit is about milk, its nutritive value, processing, types and effect of processing on milk quality.
- *Subtopics:*
    - Nutritive value
    - Introduction to liquid milk technology (clarification, pasteurization, homogenization, fortification, sterilization)
    - Types of milk
    - Effect of processing on milk

UNIT II: EGGS (12 Hours)

- *Unit Description:* This unit is about eggs its composition and nutritive value, structure, quality, foam formation and effect of heat on egg proteins.
- *Subtopics:*
  - Composition and nutritive value
  - Structure of an egg
  - Egg quality and deterioration
  - Effect of heat on egg proteins: Green ring formation in boiled egg
  - Storage and preservation of eggs
  - Egg foams – stages of preparation and factors affecting them

UNIT III: FATS AND OILS (12 Hours)

- *Unit Description:* This unit is about types of fats and oils, their functions, spoilage, precautions to be taken while using, emulsions and RUCO.
- *Subtopics:*
  - Definitions, types of fats and oils and their functions
  - Rancidity in fat and its prevention
  - Care of fat used for frying (smoke, flash and fire points)
  - Emulsions
  - Repurpose used cooking oil (RUCO).

UNIT IV: MISCELLANEOUS FOOD PRODUCTS (12 Hours)

- *Unit Description:* This unit is about miscellaneous food items like sugar and its properties and behaviour during cooking, tea and coffee processing and flavouring compounds in spices
- *Subtopics:*
  - Sugar: Properties, sugar behaviour during cooking.
  - Tea and Coffee: Types of tea and coffee, basic processing of tea and coffee.
  - Spices and Herbs: Types and flavouring components

PRACTICAL:30 Hours

No. of Students per Practical Class Group: 10-15

1. Determination of pH of different foods. (2 Hours)
2. Selection and purchase criteria of raw materials (cereal, pulses, vegetables, fruits and eggs) (2 Hours)
3. Effect of heat on milk processing. (2 Hours)
4. Effect of acid and alkali on milk processing. (2 Hours)

5. Egg white foam formation (2 Hours)
6. Factors affecting egg white foam stability (4 Hours)
7. Green ring formation in boiled eggs and its prevention (2 Hours)
8. Determination of the quality of an egg (2 Hours)
9. Behaviour of sugar at various temperatures (4 Hours)
10. Preparation of crystalline candies (2 Hours)
11. Preparation of non-crystalline candies (2 Hours)
12. Determination of smoke point of different fats and oil (2 Hours)
13. Preparation of emulsions – mayonnaise (2 Hours)

ESSENTIAL/ RECOMMENDED READINGS (Theory and Practical):

1. Suri, S. & Malhotra, A. (2014). *Food Science Nutrition and Safety*. Delhi: Pearson India Ltd.
   i. Online Question Bank and student E Resources: https://wps.pearsoned.co.in/suri_fsns_1/
   ii. Online Instructor Resources: www.pearsoned.co.in/sukhneetsuri
2. Sethi, P. &Lakra, P. (2015). *Aahar Vigyan, Poshan Evam Suraksha*. Delhi: Elite Publishing House Pvt.Ltd.
3. Srilakshmi, B. (2018). *Food Science*. Delhi: New Age International Pvt.Ltd.
4. Potter, N. & Hotchkiss, J.H. (2007). *Food Science.* 5th Edition. Delhi: CBSPublishers.
5. Rekhi,, T. & Yadav, H. (2014). *Fundamentals of Food and Nutrition.* Delhi: Elite Publishing House Pvt.Ltd.
6. Sharma, A. (2010). *Textbook of Food Science and Technology*. 2nd Edition. Delhi:IBDC Publishers

SUGGESTED READINGS:

1. Manay, N. S. &Shadakashraswamy. (2020). Foods: Facts and Principles. 3rd Edition. New Age International Pvt Ltd.
2. McWilliams, M. (2016). Foods: Experimental Perspectives. USA: Pearson.
3. Roday, S. (2018). Food Science and Nutrition. 3rd Edition. Delhi: Oxford University Press.
4. Vaclavik, V.A. & Elizabeth, C. (2014). Essentials of Food Science. 4th Edition. New York: Springer

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

B.A. (Prog.) with Food Technology (FT) as Non-Major
Category-III

DISCIPLINE SPECIFIC CORE COURSE – DSC-2A-FT: FOOD SCIENCE PART-II

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Food Science Part-II	4	3	0	1	Class XII Pass	DSC-1A-FT

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LEARNING OBJECTIVES:

1. To familiarize the students with the composition and processing of milk, egg, sugars, fats and miscellaneous food.
2. To impart concept of properties of fats and oil, sugar, egg foam stages and emulsions.

LEARNING OUTCOMES:

After completion of the course, the students will be able to:

1. Describe the composition and nutritive value of milk, egg, sugar and fats and their role in food processing.
2. Develop understanding about basic processing of milk and eggs.
3. Illustrate the behaviour of sugar at various temperatures.
4. Describe spoilage of fat scientifically, determine the smoke point of different fats and illustrate the ways to prevent rancidity of fats.

THEORY:

UNIT I: MILK **(9 Hours)**

- *Unit Description:* This unit is about milk, its nutritive value, processing, types and effect of processing on milk quality.
- *Subtopics:*
  - Nutritive value
  - Introduction to liquid milk technology (clarification, pasteurization, homogenization, fortification, sterilization)
  - Types of milk
  - Effect of processing on milk

UNIT II: EGGS (12 Hours)

- *Unit Description:* This unit is about eggs its composition and nutritive value, structure, quality, foam formation and effect of heat on egg proteins.
- *Subtopics:*
  - Composition and nutritive value
  - Structure of an egg
  - Egg quality and deterioration
  - Effect of heat on egg proteins: Green ring formation in boiled egg
  - Storage and preservation of eggs
  - Egg foams – stages of preparation and factors affecting them

UNIT III: FATS AND OILS (12 Hours)

- *Unit Description:* This unit is about types of fats and oils, their functions, spoilage, precautions to be taken while using, emulsions and RUCO.
- *Subtopics:*
  - Definitions, types of fats and oils and their functions
  - Rancidity in fat and its prevention
  - Care of fat used for frying (smoke, flash and fire points)
  - Emulsions
  - Repurpose used cooking oil (RUCO).

UNIT IV: MISCELLANEOUS FOOD PRODUCTS (12 Hours)

- *Unit Description:* This unit is about miscellaneous food items like sugar and its
  properties and behaviour during cooking, tea and coffee processing and flavouring compounds in spices
- *Subtopics:*
  - Sugar: Properties, sugar behaviour during cooking.
  - Tea and Coffee: Types of tea and coffee, basic processing of tea and coffee.
  - Spices and Herbs: Types and flavouring components

PRACTICAL: 30 Hours

No. of Students per Practical Class Group: 10-15

1. Determination of pH of different foods. (2 Hours)
2. Selection and purchase criteria of raw materials (cereal, pulses, vegetables, fruits and eggs) (2 Hours)
3. Effect of heat on milk processing. (2 Hours)

4. Effect of acid and alkali on milk processing. (2 Hours)
5. Egg white foam formation (2 Hours)
6. Factors affecting egg white foam stability (4 Hours)
7. Green ring formation in boiled eggs and its prevention (2 Hours)
8. Determination of the quality of an egg (2 Hours)
9. Behaviour of sugar at various temperatures (4 Hours)
10. Preparation of crystalline candies (2 Hours)
11. Preparation of non-crystalline candies (2 Hours)
12. Determination of smoke point of different fats and oil (2 Hours)
13. Preparation of emulsions – mayonnaise (2 Hours)

ESSENTIAL/ RECOMMENDED READINGS (Theory and Practical):

1. Suri, S. & Malhotra, A. (2014). *Food Science Nutrition and Safety*. Delhi: Pearson India Ltd.
    a. Online Question Bank and student E Resources:https://wps.pearsoned.co.in/suri_fsns_1/
    b. Online Instructor Resources: www.pearsoned.co.in/sukhneetsuri
2. Sethi, P. &Lakra, P. (2015). *Aahar Vigyan, Poshan Evam Suraksha*. Delhi: Elite Publishing House Pvt.Ltd.
3. Srilakshmi, B. (2018). *Food Science*. Delhi: New Age International Pvt.Ltd.
4. Potter, N. & Hotchkiss, J.H. (2007). *Food Science.* 5th Edition. Delhi: CBSPublishers.
5. Rekhi,, T. & Yadav, H. (2014). *Fundamentals of Food and Nutrition.* Delhi: Elite Publishing House Pvt.Ltd.
6. Sharma, A. (2010). *Textbook of Food Science and Technology*. 2nd Edition. Delhi:IBDC Publishers

SUGGESTED READINGS:

1. Manay, N. S. &Shadakashraswamy. (2020). Foods: Facts and Principles. 3rd Edition. New Age International Pvt Ltd.
2. McWilliams, M. (2016). Foods: Experimental Perspectives. USA: Pearson.
3. Roday, S. (2018). Food Science and Nutrition. 3rd Edition. Delhi: Oxford University Press.
4. Vaclavik, V.A. & Elizabeth, C. (2014). Essentials of Food Science. 4th Edition. New York: Springer

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Category-IV

COMMON POOL OF GENERIC ELECTIVES (GE) COURSES OFFERED BY DEPARTMENT OF HOME SCIENCE

GENERIC ELECTIVES (GE HS 002): SELF DEVELOPMENT AND WELLBEING

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Self Development and Wellbeing	4	3	0	1	12th Pass	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To understand the concepts of self-development and wellbeing
- To study theoretical perspectives and stages of self-development
- To understand framework and dimensions of wellbeing
- To understand the context and significance of managing emotions and wellbeing
- To study and understand activities for enhancing self-development and wellbeing

Learning outcomes

The Learning Outcomes of this course are as follows:

- The student will be able to understand the concept of self-development and parameters of wellbeing
- The student will be able to understand the theoretical perspectives on self-development and wellbeing
- The students will be able to demonstrate skills in developing and using contextually appropriate methods to promote well-being
- The student will be able to enhance their self-development and wellbeing through reflection and introspection

SYLLABUS OF GE HS 002

Unit I: Understanding the self (12 Hours)

To introduce various approaches and theories of self.
Subtopics:

- Definitions and concepts of self
- Perspectives on self
- Phases of self-development
- Theories of self-development

Unit II: Components of self-development (09 Hours)

To understand various aspects of self-development.
Subtopics:

- Components of Self- An integrated approach
- Self-concept and self esteem
- Social self and development
- Factors influencing self

Unit III: Concept, approaches and importance of wellbeing (12 Hours)

To understand basic definitions and concepts of wellbeing and interlink these with self-development.
Subtopics:

- Definitions and concept of Wellbeing
- Frameworks and dimensions of wellbeing
- Health and Wellbeing
- Happiness and Wellbeing

Unit IV: Promoting self-development and wellbeing (12 Hours)

To understand significance of activities related to wellbeing.
Subtopics:

- Managing relationships and emotions
- Happiness and emotional wellbeing
- Mindfulness and decision making
- Academics and Work-life balance
-

Practical component (if any)

PRACTICAL: 30 Hours

- An activity on self-reflection from early childhood to adolescence.
- Focused group discussion on self and wellbeing.
- Narrative analysis/: biographies and autobiographies/ Diagrammatic representation of the self)

- Selected exercises to promote wellbeing: Music, dance, literature, poetry, art, yoga, meditation, play, and theatre
- Psychometric tests- on self and wellbeing
- Session on basics of counselling
- Profile an organisation work in sector of counselling

Essential Readings

1. Burkitt, I. (2008). Social selves: Theories of self and society. Sage
2. Emmons, R. A., & Shelton, C. M. (2002). Gratitude and the science of positive psychology. Handbook of positive psychology, 18, 459-471.
3. Kakar, S. (1978). The inner world. Delhi: Oxford University Press.
4. Kakar, S. and Kakar, K. (2007). The Indian: The portraits of a people. London: Penguin/Viking.
5. Mathews, G., & Izquierdo, C. (Eds.). (2008). Pursuits of happiness: Well-being in anthropological perspective. Berghahn books.
6. Rice, F. P. (2007). Adolescent: Development, Relationship and Culture.
7. Sabharwal, N., Ranganathan, N., Singh, I. V., & Basu, S. (2017). Unit-1 Dimensions of Self: An Integrated Approach.
8. Santrock, J. (2010). LifeSpan Development: A Topical Approach, New Delhi: Tata McGraw Hill.
9. Snyder, C. R., Lopez, S. J., Edwards, L. M., & Marques, S. C. (Eds.). (2020). The Oxford handbook of positive psychology. Oxford university press.
10. Snyder, C.R., & Lopez,S.J.(2007). Positive psychology: The scientific and practical explorations of human strengths. Thousand Oaks, CA: Sage.
11. Winnicott, D. W. (2012). The family and individual development. Routledge.
12. Gough, I., & McGregor, J. A. (Eds.). (2007). Wellbeing in developing countries: from theory to research. Cambridge University Press.

Suggested Readings

1. Synder, C.R., Lopez, S.J., Pedrotti, J.T. (2011). Positive psychology: The scientific and
2. Practical explorations of human strengths. New Delhi: Sage.
3. Seligman, M. (2011). Flourish: A Visionary New Understanding of Happiness and Well-being, Atria Books. Peterson, C. A. (2006). A Primer in Positive Psychology, Oxford University Press.
4. Nettle, D.S. (2006). Happiness: The Science Behind Your Smile, Oxford University Press.
5. Lyubomirsky, S. (2013). The Myths of Happiness: What Should Make You Happy, but Doesn't, What Shouldn't Make You Happy, but Does, Penguin.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVES (GE HS 006): NUTRITION FOR THE FAMILY

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Nutrition for the Family	4	3	0	1	12^{th} Pass	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To enable students in understanding the principles of planning nutritionally adequate diets.
- To acquire knowledge about the nutritional needs and concerns of an individual throughout the life cycle.
- To make them exercise food choices consonant with good health based on sound knowledge of principles of nutrition.

Learning outcomes

The Learning Outcomes of this course are as follows:

The students will be able:

- The student will be able to comprehend the principles of planning nutritionally adequate diets.
- The student will be able to acquire knowledge about the nutritional needs and concerns of an individual throughout the life cycle.
- The student will be able to exercise food choices consonant with good health based on sound knowledge of principles of nutrition.

SYLLABUS OF GE HS 006

Unit I: Basics of nutrients requirements (06 Hours)

Concepts of estimated average requirements, recommended allowances and methods of assessing nutrient requirements in general for Indians

Subtopics:

- Concept of EAR, RDA and TUL
- Methods of assessment of nutrient requirements

Unit II: Principles of Meal Planning (06 Hours)

Concepts of food groups and food exchange lists for meal planning, factors affecting meal planning will be dealt with. Students will also be introduced to dietary guidelines for Indians.

Subtopics:

- Food groups
- Food exchange list
- Factors affecting meal planning and food related behaviour
- Dietary guidelines for Indians

Unit III: Nutrition during adulthood (18 Hours)

Physiological influence on nutrient requirements during adulthood (EAR/RDA), energy balance in adulthood, nutritional concerns and changes in requirements during pregnancy, lactation, and old age will be dealt with.

Subtopics:

- Adult men and women
- Pregnant women
- Lactating mothers
- Elderly

Unit IV: Nutrition during childhood (15 Hours)

Physiological changes during infancy, childhood and adolescence – growth and development; and their influence on nutrient requirements (EAR/RDA), concepts of nutrient requirements during these ages and nutrition concerns keeping in mind the changing food habits and importance of physical activity will be dealt with.

Subtopics:

- Infants
- Preschool children
- School children
- Adolescents

Practical component (if any)

PRACTICAL: 30 Hours

Introduction to meal planning:
- Rich sources of nutrients
- Use of food exchange lists

Planning nutritious diets for:
- Adult (Male and Female)
- Pregnant and Lactating woman
- Pre-schooler
- Adolescent
- Elderly

Planning and cooking of nutrient rich snacks/dishes for:
- Infants (Freshly prepared complementary foods)
- Packed tiffin
- Pregnancy/Lactation

Essential Readings

1. Chadha R and Mathur P eds. (2015). Nutrition: A Lifecycle Approach. New Delhi: Orient Blackswan
2. ICMR-NIN (2020). Expert Group on Nutrient Requirements for Indians, Recommended Dietary Allowances (RDA) and Estimated Average Requirements (EAR)-2020
3. Khanna K, Gupta S, Seth R, Passi SJ, Mahna R, Puri S (2013). Textbook of Nutrition and Dietetics. Delhi: Elite Publishing House Pvt. Ltd.
4. Longvah T, Ananthan R, Bhaskarachary K and Venkaiah K (2017). Indian Food Composition Tables. National Institute of Nutrition, Indian Council of Medical Research, Department of Health Research, Ministry of Health and Family Welfare, Government of India, Hyderabad.
5. NIN (2011). Dietary Guidelines for Indians-A manual. Second Edition. National Institute of Nutrition, Indian Council of Medical Research, Hyderabad.
6. Puri S, Bhagat A, Aeri, BT, Sharma A (2019). Food Exchange List: A Tool for Meal Planning. New Delhi: Elite Publishing House.
7. Seth V, Singh K, Mathur P (2018). Diet Planning Through the Lifecycle Part I: Normal Nutrition- A Practical Manual. 6th Edition. New Delhi: Elite Publishing House.
8. Siddhu, A, Bhatia, N, Singh, K, Gupta, S (2017). Compilation of Food Exchange List, Technical Series 6, Lady Irwin College, University of Delhi Publ. Global Books Organisation, Delhi.

Suggested Readings

1. Byrd-Bredbenner C, Moe G, Beshgetoor D, Berning J (2013). Wardlaw‟s Perspectives in Nutrition, McGraw- Hill International Edition, 9th edition
2. B Srilakshmi Eighth Edition (2019). Nutrition Science. New Age International Publishers.
3. Punita Sethi, Poonam Lakra (2015). Aahar Vigyan Suraksha evam Poshan.Delhi: Elite Publishing House Pvt.Ltd

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVES (GE HS 009): GENDER AND MEDIA STUDIES

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course	Department offering the course
		Lecture	Tutorial	Practical/ Practice			
Gender and Media Studies	4	3	0	1	12th Pass	NIL	Home Science

Learning Objectives

The Learning Objectives of this course are as follows:

- To introduce the concepts relating to gender and to sensitize the students to the construction of gender.
- To highlight the various aspects in gender and development, and its dimensions, theories and approaches.
- To understand the gender-based issues of equality and equity through a study of development indices and feminist theories and perspectives.
- To learn about the inter-relationships between portrayal of women in media and the status of women as well as the role media can play in empowerment of women.

Learning outcomes

The Learning Outcomes of this course are as follows:
After studying, students will be able to:

- The student will be able to understand the concept of gender and socio-cultural practices impacting the construction of gender.
- The student will be able to understand the theories and approaches of feminism.
- The student will be able to comprehend the various aspects in gender and development, and its dimensions, theories
    - and approaches.
- The student will be able to critique the role of the media in promoting gender equity and empowerment.

SYLLABUS OF GE HS 009

Unit I: Social Construction of Gender (12 Hours)

The Unit aims to critically understand the concept of gender and socio-cultural practices impacting the social construction of gender.
Subtopics:

- Concept of gender and sex
- Socialization and construction of gender
- Patriarchal social order and status of women
- Shifts in Status of women – historical and contemporary perspectives on status of women

Unit II: Gender and Development (12 Hours)

The Unit highlights the various aspects in gender and development and focuses on its dimensions, theories and approaches.
Subtopics:

- Concept of Gender, Development and Indicators
- Approaches to women's participation in development
- Invisibility of women's work and economic participation
- Gender differentials in various sectors of development
- Life Cycle Approach to gender studies (violence against women)

Unit III: Feminism, Gender and Media (12 Hours)

This Unit focuses on historical evolution of feminism and perspectives on gender and media.
Subtopics:

- Feminist theories; A short introduction
- Gender and Media; Theoretical perspectives - portrayal and representation
- Theory of Visual Pleasure - Male Gaze (Laura Mulvey);
- Queer Theory (Judith Butler)
- Masculine Hegemony (R.W. Connell)
- Framework for gender responsive media and gender mainstreaming

Unit IV: Gender and Empowerment (09 Hours)

This Unit provides an insight on the concept of empowerment and gender equality.
Subtopics:

- Advocacy of women's rights through media
- Women's Empowerment; Historical and Contemporary Perspectives
- Women's Legal Rights and Redressal System
- Media laws related to women

Practical component (if any)

PRACTICAL: 30 Hours

- Exercises on sex and gender
- Data interpretation on gender-related indicators
- Review and content analysis of various Media: print, films/documentaries on gender issues and their critical analysis.
- Case studies on representation of gender in mainstream media from a gender perspective (print, broadcast and new media)
- Critical analysis of Laura Mulvey's notion of Male Gaze

Essential Readings

- Bhasin, Kamla (2000). Understanding Gender. New Delhi. Kaali for Women.
- Butler, J. (1999). Gender trouble: Feminism and the subversion of identity. New York: Routledge.
- Connell, R. W., & Messerschmidt, J. W. (2005). Hegemonic Masculinity: Rethinking the Concept. Gender & Society, 19(6), 829–859.
- Human Development Reports. (n.d.). Hdr.undp.org. https://hdr.undp.org/en/towards-hdr-2022
- Mulvey, L. (1989). Visual Pleasure and Narrative Cinema. In Visual and other pleasures (pp. 14-26). Palgrave Macmillan, London.

Suggested Readings

- Beauvoir, S. (2015). The Second Sex. London: Vintage Books.
- Chattopadhyay, S (2018). Gender Socialization and the Making of Gender in the Indian Context. New Delhi: Sage Publications.
- Dube, L. (2001). Anthropological Explorations in Gender-Intersecting Fields. New Delhi: Sage Publications.
- Ghadially, R (2007). Urban Women in Contemporary India. New Delhi: sage Publications.
- Goel, A. (2004). Education & Socio-Economic Perspectives of Women Development and Empowerment. New Delhi: Deep & Deep.
- Goel, A. (2004). Organisation & Structure of Women Development and Empowerment. New Delhi: Deep & Deep.
- Goel, A, Kaur, A and Sultana, A (2006). Violence against women: Issues and Perspectives. New Delhi, Deep & Deep Publishers.
- Khanna, S. (2009). Violence against Women and Human Rights. Delhi: Swastik
- Krishna, S. (Ed) (2003) Livelihood and Gender Equality in Community Resource Management. New Delhi: Sage Publications.
- Madhi, V. J et al (2014) Women's Studies in India. New Delhi: Rawat.
- Sohoni, K Neeraja, (1994), Status of Girls in Development Strategies, New Delhi, Har-Anand Publications.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVES (GE HS 014): FABRIC STUDY

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course	Department offering the course
		Lecture	Tutorial	Practical/ Practice			
Fabric Study	4	3	0	1	12^{th} Pass	NIL	Home Science

Learning Objectives

The Learning Objectives of this course are as follows:

- To briefly study the fabric components.
- To enhance awareness of various commercially available fabrics.
- To understand the properties and end uses of the various types of fabrics.

Learning outcomes

The Learning Outcomes of this course are as follows:
After studying, students will be able to:

- The student will be able to understand the components of a textile fabric.
- The student will be able to identify the various commercially available fabrics.
- The student will be able to appropriately select fabrics based on their properties, cost and recommended end-use.

SYLLABUS OF GE HS 014

UNIT I: Fabric components (09 Hours)

In this unit, students will be able to understand the basics of fibres, yarns and fabric.

Subtopics:

- Fibres and yarns
- Methods of fabric construction

Fabric finishing- dyeing, printing, aesthetic and functional finishes

Unit II: Commercially important woven fabrics: Identification, properties and end use (21 Hours)

In this unit, students will gain an understanding of various types of woven fabrics

Subtopics:

- **Cotton and other Cellulosic Fabrics**
  - Lightweight fabrics- Mulmul, Voile, Organdy, etc.
  - Medium weight fabrics- Cambric, Poplin, Cotton, Rubia, Denim, Chambray, Seer-sucker, Eyelash dobby, Schiffli, Jute, Linen, etc.
  - Heavy weight fabrics- Canvas, Casement, Gabardine, Damask, Corduroy, Velvet, Terry, etc.
- **Silk and Wool fabrics**
  - Lightweight fabrics- Silk Crepe, De Chine, Georgette, Chiffon, Organza, etc.
  - Medium/Heavy weight fabrics- Flat silk, Satin, Taffeta, Dupion, Shantung, Raw silk, Tussar silk, Habutai silk, Tweed
- **Man-made fibre and blended fabrics**

Art silk, Lizzy-Bizzy, Terivoile, Semi-crepe, Moss crepe, Artificial chiffon, Artificial georgette, Terrycot, Poly-satin, Lycra, Modal, Viscose

Unit III: Commercially Important Knitted and Non-woven fabrics: Identification, properties and end use (09 Hours)

In this unit, students will learn about various types of knitted and non-woven and other types of fabrics

Subtopics:

- Knitted Fabrics- Knitted Terry, Jersey, Rib Knit, Interlock knit, Pique, Velour, Scuba, Fleece, etc.
- Non-wovens- Different types and weights
- Others- Leatherette, Suede, Nets and Laces

Unit IV: Traditional Indian Fabrics: Identification, properties and end use (06 Hours)

In this unit, students will be learn to identify various types of traditional Indian fabrics

Subtopics:

Selected woven, embroidered, painted, printed and dyed traditional Indian textiles.

Practical component (if any)

PRACTICAL: 30 Hours

Unit I: Identification of various types of fibres, yarns, fabrics and weaves

- Learn to identify the different components of a fabric, its construction and other essential properties

Subtopics:

- Identification of common textile fibres
- Identification of textile yarns
- Identification of fabric types: Woven, Knitted, Non-Wovens and others
- Identification of fabric weave
- Identification of various types of woven fabrics in terms of Weight
- Thread Count

Unit II: Collection of swatches for portfolio preparation of woven, knitted, non-woven and traditional Indian fabrics

Learn to recognise various types of commercially available fabrics

Subtopics:

- Preparation of portfolio of commonly available fabrics
- Commercially important Woven Fabrics

Commercially important Knitted, Non-Woven and other fabrics o Traditional Indian Fabrics

Essential Readings

- Corbman P. B., (1989), Textiles- Fibre to Fabric, 6th edition, McGraw Hill, New York.
- Hollen N., Saddler J., Langford A.L., Kadolph S.J., (1988), Textiles, 6 th Edition, Macmillan Publishing Company New York, USA
- Joseph, M.L., (1988) Essentials of Textiles (6th Edition), Holt, Rinehart and Winston Inc., Florida.
- Rastogi, D. (Ed.) and Chopra, S. (Ed.), (2017), Textile Science, Orient Black Swan.
- Sekhri S., (2011) Textbook of Fabric Science: Fundamentals to Finishing, PHI Learning, Delhi.
- Chattopadhyay, K.D., 1995, Handicrafts of India, Wiley Eastern Limited, N Delhi.

Suggested Readings: (Practical)

- Corbman P. B., (1989), Textiles- Fibre to Fabric, 6th edition, McGraw Hill, New York.
- Chelna Desai, 1988, Ikats Textiles of India, Chronicle Books, India.
- Pizzuto's J.J. "Fabric Science", Fairchild Publication, New York.
- Hollen N., Saddler J., Langford A.L., Kadolph S.J., (1988), Textiles, 6th Edition, Macmillan Publishing Company New York, USA
- Das, Shukla, 1992, Fabric Art- Heritage of India, Abhinav Publications, N Delhi.
- Chelna Desai, 1988, Ikats Textiles of India, Chronicle Books, India
- Tholia A., (2013) Understanding Fabrics- A practical Approach, 2nd edition, Sarv

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

Credit distribution, Eligibility and Pre-requisites of the Course

GENERIC ELECTIVES (GE HS 018): INNOVATIVE DESIGN PRACTICES

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course	Department offering the course
		Lecture	Tutorial	Practical/ Practice			
Innovative Design Practices	4	3	0	1	12th Pass	NIL	Home Science

Learning Objectives

The Learning Objectives of this course are as follows:

- To sensitize students towards innovation in design to improve the quality of life of users as well as comply with environment protection.
- To stimulate the students to engage in creativity and integrate sustainability in their design endeavours.

Learning outcomes

The Learning Outcomes of this course are as follows:
After studying, students will be able to:

- The student will be able to get sensitized towards innovation and creativity through innovative and sustainable design practices and techniques.
- The student will be able to carry out development of product and prototyping from a sustainability perspective.
- The student will be able to brainstorm new product ideas in a systematic manner.

Unit I: Introduction to Innovation in Design (09 Hours)

The focus of this unit would be on understanding the theoretical concepts related to innovation, design and creativity.
Subtopics:

- Concept of Design, Innovation, and Creativity
- Theories and principles of design and innovation
- Challenges to innovation

Unit II: Methods and techniques for Innovation in Design (12 Hours)

This unit focuses on studying the various methods and techniques used for design innovation
Subtopics:

- Understanding disruptions in innovation approaches, case analysis
- Process of creativity and design
- Methods of ideating, creating and implementing innovative design ideas

Unit III: Approaches for Sustainability in Design (12 Hours)

This unit attempts to acquaint the students with contemporary techniques and approaches for integrating concepts of sustainability in design.
Subtopics:

- Role of sustainability in design practice
- Emerging trends and sustainable methods and techniques of design
- Sustainable Materials: reclaimed and eco-friendly composite materials
- Contemporizing traditional designs
- Circular Economy as a pathway to sustainability in design

Unit IV: Design Development and Presentation (12 Hours)

This unit will develop competence amongst students towards creating and executing their innovative design ideas.
Subtopics:

- Critical evaluation of existing designs:
  - Products
  - Interiors and Space
- Case study of Innovative design practices related to:
  - Interiors and Space

Product

SYLLABUS OF GE HS 018

Practical component (if any)

PRACTICAL: 30 Hours

Unit I: Brainstorming Methods

Activities:

- Sessions on Tinkering Lab
- Engaging students in a practical setup for brainstorming
- Narration / Documentation of brainstorming sessions
- Workshop/ Field Visits- Contemporary discussion with the artists and designers

Unit II: Project on Innovative Design Idea

Activities:

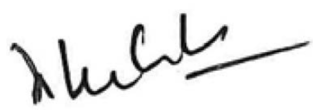
- Case study on Reuse/ Recycle/ Reclaim products
- Minor project on sustainable materials
- Portfolio on Innovative Design Idea
- Description
- Relevance of the idea in present contextDigital Presentation / Prototype of Innovative Design Idea

Essential Readings

- Brown, T. (2019). Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation. ISBN-13: 9780062856623
- Soni, P. (2020) Design Your Thinking: The Mindsets, Toolsets and Skill Sets for Creative Problem-solving.
- Jones, J. C. Design Methods. ISBN-13: 978-0471284963
- Ashby, M.F, Johnson, K. Materials and Design: The Art and Science of Material Selection in Product Design.
- Allwood, J, Cullen, J. (2011). Sustainable Materials.
- Desai, A, Mital, A. Sustainable Product Design and Development. ISBN: 9780367343217
- William McDonough and Michael Braungart (2002). "Cradle-to-Cradle: Remaking the Way We Make Things", North Point Press, New York.
- Lance Hosey, (2012). "The Shape of Green: Aesthetics, Ecology, and Design", Island Press, Washington, D.C.

Suggested Readings

- Norman, A.D. The Design of Everyday Things: Revised and Expanded Edition.
- Kaptelinin, V. Affordances and Design.
- Pivot. From Concept to Product Launch: A guide to Product Development.
- Monto Mani and Prabhu Kandachar (Eds) (2015), "Design for sustainable well-being and empowerment: Selected Papers", IISc, Bangalore and TU Delft, The Netherlands.
- Papanek, V. (1984), "Design for the Real World", 2nd Edition, London: Thames & Hudson.
- White Lemon, "365 Days of DIY", Create Space Independent Publishing Platform, 2016.
- Jaffe, S.B et.al. (2020). Sustainable Design Basics.



REGISTRAR

DEPARTMENT OF BOTANY
B.Sc. (H) Botany
Category-I

DISCIPLINE SPECIFIC CORE COURSE - 7: Phycology - The World of Algae

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Phycology - The World of Algae DSC-7	4	**2**	**0**	**2**	Class XII pass	Nil

Learning Objective:
To provide students with in-depth knowledge of the unique group of algae that are the primary photosynthetic organisms.

Learning Outcomes:

By studying this course students will gain basic knowledge on algae, with reference to:
● the diversity and general characteristics.
● distinguishing features of taxa belonging to different families.
● the various ecological and economic benefits.

Unit 1: Introduction to Algal World **6 hours**
Relevance of studying algae – Industrial (food, feed, fodder), Environmental (climate change, biofuel, acidification of oceans), Evolutionary (range of thallus organization); General characteristics; Ecology, diversity and distribution; Range of thallus organization; Cell structure; Criteria for classification (cell wall, pigment system, reserve food, flagella); Reproduction and life cycle patterns; Classification by Fritsch; Evolutionary classification of Lee (only up to groups); Significant contributions of eminent Phycologists.

Unit 2: Cyanophyceae (Blue-Green Algae) **3 hours**
General characteristics; Occurrence; Cell structure; Heterocyst (structure and function); Morphology, reproduction and life-cycle of *Nostoc*, economic importance.

Unit 3: Chlorophyceae (Green Algae) **6 hours**
General characteristics; Occurrence; Cell structure; Morphology, reproduction and life-cycle of *Chlamydomonas*, *Volvox*, *Chlorella, Ulva*, *Oedogonium*, *Coleochaete*; *Chara*; Structure and evolutionary significance of *Prochloron*, economic importance.

Unit 4: Xanthophyceae (Yellow-Green Algae) 2 hours
General characteristics; Occurrence; Morphology, reproduction, and life-cycle of *Vaucheria*, economic importance.

Unit 5: Bacillariophyceae (Diatoms) and Dinophyceae (Dinoflagellates) 3 hours

General characteristics, Occurrence, morphology, unique features, economic importance.

Unit 6: Phaeophyceae (Brown Algae) 4 hours
General characteristics; Occurrence; Morphology, reproduction, and life-cycle of *Ectocarpus* and *Sargassum*, economic importance.

Unit 7: Rhodophyceae (Red Algae) 4 hours
General characteristics; Occurrence; Morphology, reproduction, and life-cycle of *Gracilaria*, economic importance.

Unit 8: Recent advances in algal studies 2 hours
Model systems and their applications in genetic, molecular and evolutionary studies.

Practicals 60 hours

1. Study of algal diversity in different habitats through botanical excursion and submission of digital catalogue/report of various species observed.
2. ***Nostoc***: Study of vegetative, reproductive structures from temporary mounts and permanent slides; Ultrastructure of Heterocyst through Electron Micrographs.
3. ***Chlorella***: Study of vegetative, reproductive structures from temporary mounts. Study of ultrastructure through Electron Micrographs.
4. ***Volvox***: Study of vegetative, reproductive structures from temporary mounts and permanent slides.
5. ***Oedogonium***: Study of vegetative, reproductive structures from temporary mounts and permanent slides.
6. ***Coleochaete***: Study of vegetative, reproductive structures from temporary mounts and permanent slides.
7. ***Chara***: Study of vegetative, reproductive structures from temporary mounts, specimens and permanent slides.
8. ***Vaucheria***: Study of vegetative, reproductive structures from temporary mounts and permanent slides.
9. **Diatoms** and **Dinoflagellates**: Study vegetative, reproductive structures of at least two taxa from water bodies.
10. ***Ectocarpus***: Study of vegetative, reproductive structures from temporary mounts and permanent slides.
11. ***Sargassum***: Study of vegetative, reproductive structures from temporary mounts, specimens and permanent slides.
12. ***Polysiphonia/ Gracilaria***: Study of vegetative, reproductive structures from temporary mounts and permanent slides.

Suggested Readings:

1. Bold, H.C. and Wynne, M.J. (1985). Introduction to the Algae: Structure and Reproduction, 2nd edition. Prentice-Hall International INC.
2. Kumar, H.D. (1999). Introductory Phycology, 2nd edition. Affiliated East-West Press, New Delhi.
3. Lee, R.E. (2018). Phycology, 4th edition: Cambridge University Press, Cambridge.
4. Sahoo, D. and Seckbach, J. (2015). The Algae World. Springer, Dordrecht.
5. Sahoo, D. (2000).Farming the Ocean: Seaweed Cultivation and Utilization. Aravali Book International, New Delhi.

Additional Resources:

1. Van den Hoek, C., Mann, D.G., Jahans H.M. (1995). Algae: An Introduction to Phycology. Cambridge University Press.
2. Sharma, O.P. (2011). Algae. Tata Mc Graw Hill Education Private Limited, New Delhi.
3. Smith, G.M. (1955). Cryptogamic Botany. Vol.1.Algae and Fungi. McGraw-Hill Book Company, New York.
4. Vashishta, B.R., Singh, V.P. and Sinha, A.K. (2012). Botany for Degree Students: Algae. S Chand Publishing, New Delhi.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 8: Bryophytes, Pteridophytes and Gymnosperms

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Bryophytes, Pteridophytes and Gymnosperms DSC – 8	**4**	**2**	**0**	**2**	Class XII pass	**Nil**

Learning Objectives:

- Provide a deep understanding of morphology, anatomy, reproduction and developmental biology of these unique groups of non-flowering plants.
- Enhance understanding of diversity, economic value, taxonomy in representative members of phylogenetically important groups.

Learning Outcomes:

At the end of this course students will be able to:

- identify and describe the group of plants that have given rise to land habit and the flowering plants.
- comprehend various phenological stages of the plants belonging to the sub-groups – bryophytes, pteridophytes and gymnosperms.

Unit 1: Bryophytes **9 hours**

Origin of bryophytes through green algal ancestor; Morphology and Reproduction of *Marchantia*, *Anthoceros* and *Funaria* with fertilization & spore dispersal mechanism (excluding developmental stages). Progressive sterilization of sporogenous tissue; Ecological and economic importance of bryophytes with special reference to *Sphagnum*.

Unit 2: Pteridophytes **9 hours**

Fossil pteridophytes (*Rhynia*). Morphology and Reproduction *of Selaginella*, *Equisetum* and *Pteris* (excluding developmental stages). Apogamy and apospory; Heterospory and seed habit; Stelar evolution. Economic importance.

Unit 3: Gymnosperms **9 hours**

Morphology, Sstem anatomy (significance of transfusion tissue) and Reproduction of *Cycas*, *Pinus* and *Gnetum*(excluding developmental stages and secondary growth). Economic importance.

Unit 4: Recent Advances **3 hours**

Model systems (*Physcomitrella*, *Ceratopteris*, *Ephedra*) and their applications in genetic, molecular and evolutionary studies.

Practicals: **60 hours**

1. *Riccia* – Morphology: Vegetative and reproductive structures (Specimen).

2. *Marchantia* - Morphology; V.S. of thallus through Gemma cup, whole mount of Gemmae (temporary slides); V.S. of Vegetative thallus, Antheridiophore, Archegoniophore, L.S. of Sporophyte (permanent slides).

3. *Pellia* - Morphological details through specimens/permanent slides; L.S. Sporophyte (permanent slide).

4. *Porella* - Vegetative Morphological details through specimens/permanent slides.

5. *Anthoceros* – Morphology; Dissection of sporophyte (to show stomata, spores, pseudoelaters, columella) (temporary slide), V.S. of thallus (permanent slide).

6. *Funaria* - Morphology; T.S. Stem (temporary and permanent slides both); Sporophyte: operculum, peristome, spores (temporary slides); Antheridial and archegonial heads, L.S. of capsule, W.M. of protonema (Permanent slides).

5. *Psilotum* – Morphology (specimen); T.S. of rhizome, stem and synangium (permanent slides).

6. *Selaginella* – Morphology (specimen); W.M. of leaf with ligule, T.S. of stem, L.S. of strobilus, W.M. of microsporophyll, megasporophyll (temporary slides); T.S. of rhizophore (permanent slide).

7. *Equisetum* – Morphology (specimen), T.S. of internode, L.S. of strobilus, T.S. of strobilus, W.M. of sporangiophore, W.M. of spores (wet and dry) (temporary slide).

8. *Pteris* - Morphology, T.S. of rachis, V.S. of sporophyll (temporary slides), T.S. of rhizome, W.M. of prothallus with sex organs and young sporophyte (permanent slide).

9. *Cycas* – Morphology, T.S. of coralloid root, T.S. of rachis, V.S. of leaflet, V.S. of microsporophyll, W.M. of spores (temporary slides); T.S. of stem, T.S. of root, L.S. of ovule (permanent slide).

10. *Pinus* - Morphology, T.S. of Needle, L.S. and T.S. of male cone, W.M. of microsporophyll (temporary slides); T.S. of stem, R.L.S. and T.L.S. of stem, L.S. of female cone (permanent slide).

11. *Gnetum* - Morphology (stem, male & female cones); T.S. of stem, L.S. of ovule (permanent slide).

12. Botanical Excursion and submission of digital catalogue/report of various species observed.

Suggested readings:

1. Bhatnagar, S.P., Moitra, A. (2023). Gymnosperms. 2nd edition, New Delhi, Delhi: New Age International (P) Ltd Publishers.
2. Kaur I.D., Uniyal P.L. (2019). Text Book of Gymnosperms. New Delhi, Delhi: Daya Publishing House.
3. Kaur I.D., Uniyal P.L. (2019). Text Book of Bryophytes. New Delhi, Delhi: Daya Publishing House.
4. Kaur I.D. (2023). Text Book of Pteridophytes. New Delhi, Delhi: Daya Publishing House.
5. Parihar, N.S. (2019). An Introduction to Embryophyta. Vol. II: Pteridophyta. Surjeet Publications.

Additional Resources:

1. Campbell, N.A., Reece J.B., Urry L.A., Cain M.L., Wasserman S.A., Minorsky P.V., Jackson, R.B. (2020). Biology. San Francisco, SF: Pearson Benjamin Cummings.
2. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R., (latest edition). Biology. New Delhi, Delhi: Tata McGraw Hill.
3. Singh, H. (1978). Embryology of Gymnosperms. Berlin, Germany. GebruderBorntraeger.
4. Vashishta, P.C., Sinha, A.K., Kumar, A. (2022). Botany For Degree Students Pteridophyta, New Delhi, Delhi: S. Chand Publication. Delhi, India.
5. Vashistha, B.R., Sinha, A.K., Kumar, A. (2010). Botany For Degree Students, Bryophyta. New Delhi, Delhi: S Chand Publication.
6. Parihar, N.S. (1965). An Introduction to Embryophyta. Vol. I: Bryophyta. Allahabad, UP: Central Book Depot.
7. Puri, P. (1973). Bryophytes. New Delhi, Delhi, Atma Ram and Sons.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 9: Genetics and Plant Breeding

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Genetics & Plant Breeding DSC-9	4	2	0	2	Class XII pass	Nil

Learning Objectives:

- To apprise students with the basic principles of Genetics
- To enhance the applications of genetics in plant breeding and agriculture.

Learning Outcomes:

On completion of the course the students will be able to:

- understand the fundamentals of Mendelian inheritance and its deviation in gene interactions.
- describe the concepts of linkage and crossing over and their usage in constructing gene maps.
- become familiar with pedigree analysis.
- learn about principles of population genetics
- gain knowledge about gene mutations and inherited disorders
- learn about various plant breeding techniques / methods

Unit 1. Mendelian Genetics **6 hours**

Mendelism: History; Principles of inheritance, deviations (Incomplete dominance and co-dominance); Chromosome theory of inheritance; Multiple allelism; lethal alleles; Epistasis; Pleiotropy; Penetrance and expressivity; Polygenic inheritance; brief introduction to sex determination.

Unit 2. Extra-Nuclear Inheritance **4 hours**

Chloroplast and mitochondrial genomes; Chloroplast Inheritance: Variegation in Four O` clock plant; Mitochondrial inheritance in yeast; Maternal effect (Shell coiling in Snails).

Unit 3. Linkage, crossing over and chromosome mapping **5 hours**

Linkage and crossing over, Cytological basis of crossing over (Creighton and McClintock experiment in Maize); three factor crosses; interference and coincidence; Sex linkage (*Drosophila*)

Unit 4. Variation in Chromosome number and structure **4 hours**

Deletion; Duplication; Inversion; Translocation; Euploidy and aneuploidy (In Brief).

Unit 5. Mutations **4 hours**

Mutation types; Muller's CIB method, Molecular basis of mutations; Chemical mutagens (Base analogs, deaminating, hydroxylating, alkylating and intercalating agents) and Physical mutagens (Ionising and Non ionising radiations); Transposable genetic elements and their significance (Basic concept).

Unit 6. Population and evolutionary genetics **3 hours**

Hardy Weinberg law (Allele frequencies, genotype frequencies); speciation (modes of speciation and genetics of speciation).

Unit 7. Plant Breeding **4 hours**

Plant breeding- Principle and Practices, domestication and plant introduction (primary and secondary introduction), selection and its types: pure line selection, mass selection and clonal selection; hybridizations (inter-specific and intra-specific), heterosis and its significance.

Practicals: **60 hours**

1. To study meiosis in *Allium cepa* through squash preparation of anthers.
2. To study mitosis in *Allium cepa* through squash preparation of root tips.
3. To understand the deviations of Mendelian dihybrid ratios (12:3:1, 9:3:4, 9:7, 15:1, 13:3, 9:6:1) involved using the seed mixture given. Genetic ratio to be calculated using Chi square analysis.

4. Human Genetics:
   a) Study of autosomal & sex-linked dominant & recessive inheritance through pedigree analyses.
   b) ABO blood group testing using kits,
   c) To study the syndromes (Down's, Klinefelter's, Turner's, Edward's & Patau) through karyotypes
5. To calculate allelic and genotypic frequencies of human dominant and recessive traits using Hardy- Weinberg's principle.
6. To study Xeroderma pigmentosum, Sickle cell anaemia, albinism, haemophilia and colour blindness (Ishihara charts may be used to study colour blindness)
7. To study chromosomal aberrations:
   a) Quadrivalents, lagging chromosomes, dicentric/inversion bridge through photographs/permanent slides
   b) Reciprocal translocation through squash preparations of *Rhoeo* anthers.

8. Demonstration of basic methods of plant breeding (hybridizations): Emasculation, bagging and tagging using available plant material in pots/gardens/field.

Suggested Readings:

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (1991). Principles of Genetics, 8th edition. New Delhi, Delhi: John Wiley & sons.
2. Griffiths, A.J.F., Doebley,J., Peichel, C, Wassarman D (2020). Introduction to Genetic Analysis, 12th edition. New York, NY: W.H. Freeman and Co.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2020). Concepts of Genetics, 12th edition. San Francisco, California: Benjamin Cummings.
4. Pierce, B. A. (2020). Genetics: A Conceptual Approach, 7th Edition, Macmillan

5. Campbell, N.A., Reece J.B., Urry L.A., Cain M.L., Wasserman S.A., Minorsky P.V., Jackson, R.B. (2020). Biology. San Francisco, SF: Pearson Benjamin Cummings.
6. Singh, B.D., (2022). Plant Breeding: Principles and Methods. New Delhi, Medtech Publishers

Additional Resources:

1. Russell, P. J. (2010). Genetics- A Molecular Approach. 3rd Edition. Benjamin Cummings
2. Snustad, D.P., Simmons, M.J. (2016). Principles of Genetics, 7th Edition. New Delhi, Delhi: John Wiley & sons
3. Hartl, D.L., Ruvolo, M. (2019). Genetics: Analysis of Genes and Genomes, 9th edition, Jones and Bartlett Learning.
4. Singh, B. D. (2023). Fundamentals of Genetics, 6th edition. MedTech.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

POOL OF DISCIPLINE SPECIFIC ELECTIVES

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE -1): Evolutionary Biology of Plants

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Evolutionary Biology of Plants **DSE-1**	**4**	**2**	**0**	**2**	Class XII pass	**Nil**

Learning Objectives:

- This course builds on the fundamental points introduced in the core course on Plant Diversity and Evolution and presents a synthesis of various theories, concepts, evidence and methods to study evolution.

Learning Outcomes:

At the end of this course the students will be able to:

- understand the essential theories in evolution
- differentiate between micro and macroevolution and the forces shaping evolution
- construct phylogenetic trees based on morphological and molecular data
- understand evolution of life.

Unit 1: Historical Perspective of Eevolutionary Cconcepts **4 hours**

Pre-Darwinian ideas, Lamarckism, Darwinism, Post-Darwinian era – Modern synthetic theory, Neo-Darwinism

Unit 2: Origin of Life **3 hours**

Chemogeny – An overview of pre-biotic conditions and events; experimental proofs to abiotic origin of micro- and macro-molecules. Current concept of chemogeny – RNA first hypothesis. Biogeny – Cellular evolution based on proto-cell models (coacervates and proteinoid micro-spheres). Evolution of eukaryotes from pprokaryotes

Unit 3: Evidences of Evolution **4 hours**

Paleobiological– Concept of Stratigraphy and geological timescale; fossil study
Anatomical & Embryological – Vestigial organs; homologous and analogous organs (concept of parallelism and convergence in evolution)
Taxonomic –Transitional forms/evolutionary intermediates, living fossils
Phylogenetic – morphology, protein (Cytochrome C) and gene (Globin gene family) based

Unit 4: Microevolution and Macroevolution **8 hours**

Hardy Weinberg equilibrium; Founder effect, Natural and artificial selection. Levels of selection.

Inferring phylogenies- Gene trees, species trees; Patterns of evolutionary change; Adaptive radiation, Evolution and development (evo-devo); Biodiversity- Estimating changes in biodiversity; Taxonomic diversity through the Phanerozoic era.

Unit 5. Forces of Evolution 3 hours

Mutation, Geneflow, Selection, Genetic Drift, Co-adaptation and co-evolution, Anthropogenic activities, Extinction (in brief)**-** Periodic and Mass-scale – Causes and events.

Unit 6. Speciation 4 hours

Species concept, Modes of speciation – Allopatric; sympatric; peripatric; Patterns of speciation – Anagenesis and Cladogenesis; Phyletic gradualism and Punctuated eequilibrium (Quantum evolution); Basis of speciation – Isolating mechanisms.

Unit 7. Evolution of Land Plants 4 hours

Origin of land plants – Terrestrial algae and Bryophytes; alternation of generations. Early vascular plants – Stelar evolution; Sporangium evolution; seed habit and evolution of seed. Angiosperms – Phylogeny of major groups.

Practicals 60 hours

1. Study of different types of fossils, connecting links/transitional forms and Living fossils (Specimens/slides/photographs)
2. Sampling of quantitative characters (continuous and discontinuous) in a population(height, weight, number of nodes etc)
3. Study of adaptive strategies (colouration, co-adaptation and co-evolution); (Specimens/photographs)
4. Calculations of genotypic, phenotypic and allelic frequencies from the data provided
5. Simulation experiments using coloured beads/playing cards to understand the effects of Selection and Genetic drift on gene frequencies
6. To study and interpret Phylogenetic trees (reading and using trees) - minimum of three examples.

Suggested Readings:

1. Campbell, N.A., Reece J.B., Urry L.A., Cain M.L., Wasserman S.A., Minorsky P.V., Jackson, R.B. (2020). Biology. San Francisco, SF: Pearson Benjamin Cummings.
2. Ridley, M. (2004). Evolution. III Edn. Blackwell Pub., Oxford.
3. Hall, B. K., Hallgrimson, B. (2008) Strickberger's Evolution. IV Edn. Jones and Barlett.
4. Zimmer, C., Emlen, D. J. (2013). Evolution: Making Sense of Life. Roberts & Co.
5. Futuyma, D. (1998). Evolutionary Biology. III Edn. Sinauer Assoc. Inc.
6. Barton, Briggs, Eisen, Goldstein and Patel. (2007). Evolution. Cold Spring Harbor Laboratory Press.
7. Nei, M., Kumar S. (2000). Molecular Evolution and Phylogenetics. Oxford University Press, New York.
8. Futuyma, J. D., Kirkpatrick, M. (2017). Evolution, 4th Ed. Sinauer, Sunderland, MA: Sinauer Associates.

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE -2): Biostatistics & Bioinformatics for Plant Sciences

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical / Practice		
Biostatistics & Bioinformatics for Plant Sciences **DSE-2**	**4**	**2**	**0**	**2**	Class XII pass	**Nil**

Learning Objective:

- To train students in using computational and mathematical tools to solve biological problems.

Learning Outcomes:

At the end of this course students will be able to:

- use the various online databases and resources for accessing biological data.
- use the different methods of alignment of DNA, RNA and protein sequences and interpret the significance of the same.
- understand the descriptive and inferential statistical tests for interpretation of experimental data.

Unit 1- Introduction to Bioinformatics **3 hours**

Historical background; Aims and scope; Bioinformatics in Genomics, Transcriptomics, Proteomics, Metabolomics; Applications of bioinformatics in crop improvement

Unit 2- Biological databases **4 hours**

Introduction to biological databases - Primary, secondary and composite databases. Study of following databases: NCBI (GenBank, PubChem, PubMed and its tools (only BLAST)), introduction to UniProt, PDB, PlantPepDB.

Unit 3- Basic concepts of Sequence alignment **4 hours**

Similarity, identity and homology. Concepts of alignment (gaps and penalty); Alignment – pairwise and multiple sequence alignments

Unit 4- Molecular Phylogeny **4 hours**

Introduction, methods of construction of phylogenetic trees: maximum parsimony (MP), maximum likelihood (ML) and distance (Neighbour-joining) methods.

Unit 5- Introduction to Biostatistics **2 hours**

Definition, Basics of descriptive and inferential statistics; Limitations and applications.

Unit 6- Data and sampling methods **3 hours**
Primary and secondary data; Sampling methods (in brief); tabulation and presentation of data.

Unit 7- Measures and deviations of central tendencies **4 hours**
Dispersion - range, standard deviation, mean deviation, standard error, skewness and kurtosis, quartile deviation –merits and demerits; Coefficient of variation.

Unit 8-Correlation and Regression **3 hours**
Correlation - types and methods of correlation (I. E. Karl Pearson and Spearman Rank method), Introduction to simple regression equation; similarities and dissimilarities between correlation and regression.

Unit 9- Statistical tests **3 hours**
Statistical inference - hypothesis – (simple hypothesis), student's t test, chi-square test.

(Note: Numerical based questions of unit 7, 8 and 9 should be covered only in practical)

Practicals **60 hours**
1. Biological databases (NCBI, UniProt, PlantPepDB)
2. Literature retrieval from PubMed
3. Sequence retrieval (protein and gene) from NCBI (formats - FASTA, GenBank and GenPept formats)
4. Protein Structure retrieval from PDB (in pdb format) and visualization by viewing tools (Ras Mol/ J mol/Mol*/Swiss 3D Viewer/Pymol)
5. Multiple sequence alignment (MEGA/Clustal omega)
6. Construction of phylogenetic tree (PHYLIP/ MEGA/ Clustal omega).
7. Calculation of standard deviation and coefficient of variation through manual calculation and using Microsoft Excel, using only ungrouped data)
8. Calculation of correlation coefficient values by Karl Pearson's /Spearman Rank methods (through manual calculation and using Microsoft Excel)
9. Student's t-test (using Microsoft Excel), chi square test (Manual and using Microsoft Excel)

Suggested Readings:

1. Ghosh, Z., Mallick, B. (2008). Bioinformatics – *Principles and Applications*, 1st edition. New Delhi, Delhi: Oxford University Press.
2. Baxevanis, A.D., Ouellette, B.F., John (2005). Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 3rd edition. New Jersey, U.S.: Wiley & Sons, Inc.
3. Roy, D. (2009). Bioinformatics, 1st edition. New Delhi, Delhi: Narosa Publishing House.
4. Zar, J.H. (2012). Biostatistical Analysis, 4th edition. London, London: Pearson Publication.
5. Campbell, R.C. (1998). Statistics for Biologists. Cambridge, U.S.A.: Cambridge University Press

Additional Resources:

1. Pevsner J. (2009). Bioinformatics and Functional Genomics, 2nd edition. New Jersey, U.S.: Wiley Blackwell.
2. Xiong J. (2006). Essential Bioinformatics, 1st edition. Cambridge, U.K.: Cambridge University Press.
3. Mount, D.W. (2004). Bioinformatics: Sequence and Genome analysis 2nd edition, Cold Spring Harbor Laboratory Press, USA.
4. Pandey, M. (2015). Biostatistics Basic and Advanced. New Delhi, Delhi: M V Learning.
5. Khan, I.A., Khanum, A., Khan S., (2020). Fundamentals of Biostatistics, 6^{th} edition. Ukaaz Publications, Hyderabad, India.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

Category II

Botany Courses for Undergraduate Programme of study with Botany as one of the Core Disciplines

DISCIPLINE SPECIFIC CORE COURSE (DSC-.......): Plant Cell and Developmental Biology

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Plant Cell and Developmental Biology DSC	**4**	**2**	**0**	**2**	Class XII pass	**Nil**

Learning objectives:
To understand the basics of plant cell structure, development, growth and organisation of plant body.

Learning outcomes:
On completion of the course, the students will

- become familiar with the structure and functions of various components of plant cell
- understand the processes of cell growth and its regulation
- comprehend the structure, organization and functions of various tissues of the plant organs
- get acquainted with the reproductive processes in the life cycle of angiosperms
- appreciate the interactions between the developmental pathways resulting in the differentiation of plant body
- recognise the importance of plant developmental biology in the improvement and conservation of plants

Unit 1. Introduction to Plant Cell: structure and function **5 hour**
Cell as the basic unit of life; differences between plant and animal cell, prokaryotic and eukaryotic cell; Cell Theory.
Structure and functions of cell wall; cell membrane; cell organelles- nucleus, chloroplast, mitochondria, dictyosomes, endoplasmic reticulum, microbodies, cytoskeleton.

Unit 2: Cell growth **3 hours**

Cell cycle, regulation (in brief) and significance; mitosis and meiosis; cytokinesis.

Unit 3. **Polarity in plant growth** **3 hours**
Plant body as a bipolar structure; apical, basal and radial patterns of body plan; growth through primary and secondary meristems; organisation of shoot and root apices.

Unit 4. **Differentiation of tissues: vegetative organs** **6 hours**
Structure and functions of tissues (simple and complex); structure of stem, root, and leaf (dicot and monocot); principles of organ differentiation: role of transcription factors in cell, tissue, organ identity and development, cell fate determination by position, and cell-cell signalling; hormones involved in organ differentiation (very briefly).

Unit 5. Differentiation of tissues: reproductive organs **6 hours**
Anther, microsporogenesis and microgametogenesis, general structure of pollen grains and male gametes, male germ unit; ovule, megasporogenesis (monosporic, bisporic, tetrasporic) and megagametogenesis (Polygonum type), ultrastructure and significance of female germ unit; Flower development (ABC model).

Unit 6. Pollination and Fertilization **3 hours**
Pollination types, agents and adaptation; pollen germination; path of pollen tube in pistil; double fertilization

Unit 7. **Development of Embryo and Seed** **4 hours**
Endosperm types, functions; development of embryo from zygote, establishment of apical-basal and radial organisation; development of seed, modes of seed dispersal.

Practicals (60 hours)
1. Study of plant cell - through peel mount (*Tradescantia,* or any other); whole mount (*Hydrilla*) - cytoplasmic streaming.
2. Study of cell components - nucleus (Feulgen/acetocarmine staining); mitochondria (Janus green B staining); cell wall (PAS staining).
3. To study mitotic index. (pictures or permanent slides -24h-period or under different temperatures/environmental conditions may be used).
4. Study tissues and organs structure through temporary preparations of macerated material and sections - T.S. of dicot stem- *Helianthus/ Cucurbita*, *Hydrilla/ Nympaea petiole, Casuarina,* stem with secondary growth - *Helianthus, Salvadora/ Bignonia;* T.S. of monocot stem - *Zea mays*, *Dracaena;* T.S. of dicot root with and without secondary growth- *Cicer*, monocot root - *Zea mays*, V.S. of dicot leaf- *Vernonia/Hamelia*etc., *Nerium, Hydrilla;* V.S. of monocot leaf- *Zea mays, Triticum/Dracaena/Crinum;* peel mountstostudy epidermal structures - types of stomata, trichomes, laticifers; Shoot apex and root apex through micrographs.
5. Study Reproductive structures (i) Anther - T.S. of anther of any large flower like *Datura/ Hamelia/ Kigelia*); whole mounts of pollen grains; ii) pollen development through micrographs of T.S. anther at different stages of development (with secretory, amoeboid tapetum); (iii) types of ovule through permanent slides/specimens/ micrographs; (iv) Polygonum type of embryo sac development through micrographs; (v) ultrastructure of egg apparatus and central cell through micrographs.
6. Study (i) pollen viability (TTC/FDA); (ii) pollen germination; (iii) growth of pollen tube in cleared pistil.

7. Study (i) dicot and monocot embryo development (through permanent slides); (ii) structure of seed (L.S. of seed)

Suggested Readings:

1. Beck, C.B. (2010). An Introduction to Plant Structure and Development. Second edition. Cambridge University Press, Cambridge, UK.
2. Dickison, W.C. (2000). Integrative Plant Anatomy. Harcourt Academic Press, USA
3. Fahn, A. (1974). Plant Anatomy. Pergamon Press, USA
4. Mauseth, J.D. (1988). Plant Anatomy. The Benjammin/Cummings Publisher, USA
5. Esau, K. (1977). Anatomy of Seed Plants. John Wiley & Sons, Inc., Delhi.
6. Taiz, L., Zeiger, E., Moller, I.M., Murphy, A. (2015). Plant Physiology. 6th edition. Sinauer Associates, Sunderland. USA.
7. Hopkins, W.G., Huner, N.P.A. (2009). Introduction to Plant Physiology. Fourth edition, John Wiley & Sons, Inc. USA.
8. Bhojwani, S.S., Bhatnagar, S.P., Dantu, P.K. (2015). The Embryology of Angiosperms, 6th edition. New Delhi, Delhi: Vikas Publishing House.
9. Johri, B.M. (1984). Embryology of Angiosperms. Netherlands: Springer-Verlag.
10. Raghavan, V. (2000). Developmental Biology of Flowering plants. Netherlands: Springer.
11. Shivanna, K.R. (2003). Pollen Biology and Biotechnology. New Delhi, Delhi: Oxford and IBH Publishing Co. Pvt. Ltd.

Additional Resources:

1. Cutler, D.F., Botha, T., Stevenson, D.W. (2007). Plant Anatomy - An Applied Aspect. Blackwell Publishing, USA
2. Bahadur, B. Rajam, M.V., Sahijram, L., Krishnamurthy, K.V. (2015). Plant Biology and Biotechnology. Volume 1: Plant Diversity, Organization, Function and Improvement. Springer (India) Pvt. Ltd. New Delhi, Heidelberg, New York, Dordrecht, London.
3. Shivanna, K.R., Tandon, R. (2014). Reproductive Ecology of Flowering Plants: A Manual. Springer (India) Pvt. Ltd. New Delhi, Heidelberg, New York, Dordrecht, London
4. Moza M. K., Bhatnagar A.K. (2007). Plant reproductive biology studies crucial for conservation. Current Science 92:1907.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

Category III:

B.Sc. programme in Applied Life Sciences with Agrochemicals and Pest Management Botany (H) Courses for Undergraduate Programme of study with Botany as a Single Core Discipline

DISCIPLINE SPECIFIC CORE COURSE (DSC 03)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the core course			Eligibility criteria	Pre-requisite of the course (If any)
		Lecture	Tutorial	Practical/ Practice		
Genetics and Molecular Biology ALSBOTDSC03	**4**	**2**	**0**	**2**	**XII pass with Science with Biology/ Biotechnology**	**NIL**

Learning Objectives:

The learning objectives of this course are as follows:

- To understand the basic concept of Mendelian genetics and comprehensive study of Mendelian extensions.
- To provide adequate knowledge about Linkage, Crossing over and Mutations.
- To provide brief knowledge of population and evolutionary genetics.
- To impart detailed understanding about the structureof nucleic acids and their types. .
- To understand key events of Molecular biology comprising mechanism of DNA Replication, Transcription and Translation in Prokaryotes and Eukaryotes.
- To give comprehensive explanation of Transcriptional Regulation with examples of lac operon and tryptophan operon in prokaryotic as well as eukaryotic organisms along with the key concept of Gene Silencing.

Learning Outcomes:

By studying this course, students will be able to:

- Analyse the basic concepts of Mendelian genetics and its extension, Linkage and Crossing over, Mutations and population genetics.

- Explicate the mechanism of replication, transcription, translation in prokaryotes and eukaryotes.
- Comprehend the mechanism of gene regulation and gene silencing.

Unit 1: Mendelian Genetics and Extensions (3 Hours)
Mendel's work on transmission of traits, Co-dominance, Incomplete dominance, Multiple alleles, Lethal Genes, Epistasis, Pleiotropy, Polygenic inheritance, Pedigree analysis.

Unit 2: Extra-chromosomal Inheritance (2 Hours)
Cytoplasmic inheritance: Chloroplast variegation in Four 'O clock plant, Kappa particles in *Paramecium*, Maternal effect-shell coiling pattern in snail.

Unit 3: Linkage, Crossing over and Chromosomal Mapping (3 Hours)
Linkage and crossing over, Recombination mapping - two point and three points.

Unit 4: Mutations (3 Hours)
Chromosomal mutations, Deletion, Duplication, Inversion, Translocation, Aneuploidy and Polyploidy, Gene mutations.

Unit 5: Population and Evolutionary Genetics (2 Hours)
Allelic frequencies, Genotypic frequencies, Gene pool, Hardy-Weinberg Law.

Unit 6: The Genetic Material: DNA and RNA (4 Hours)
DNA structure: Salient features of double helix, Types of DNA, DNA denaturation and renaturation, Nucleosome, Chromatin structure- Euchromatin, Heterochromatin (Constitutive and Facultative), RNA structure and its types.

Unit 7: Replication of DNA (3 Hours)
Mechanism of prokaryotic DNA replication, Chemistry of DNA synthesis, Enzymes and proteins involved in DNA replication, Comparison of replication in prokaryotes and eukaryotes.

Unit 8: Transcription and Processing of RNA (4 Hours)
Mechanism of transcription in prokaryotes and eukaryotes, Split genes: concept of introns and exons, Removal of introns, Spliceosome machinery group I & group II intron splicing, alternative splicing, eukaryotic mRNA processing (5' cap, 3' poly A tail).

Unit 9: Translation (3 Hours)
Mechanism of translation in prokaryotes and eukaryotes: initiation, elongation and termination of polypeptides,Proteins and enzymes involved in translation.

Unit 10: Regulation of transcription in prokaryotes and eukaryotes (3 Hours)
Prokaryotes: Regulation of lactose metabolism and tryptophan synthesis in *E. coli*, Eukaryotes: Transcription factors, Heat shock proteins, Gene silencing.

PRACTICAL (Credit: 02)
(Laboratory practical- 15 classes of 4 hours each)

1. To study Mendelian and Non- Mendelian gene interaction ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4) through seeds.
2. To study linkage, recombination, gene mapping using marker-based data from *Drosophila*.

3. Karyotype and Idiogram preparation through photographs.
4. PTC testing in a population and calculation of allelic and genotypic frequencies.
5. Study of abnormal human karyotype and pedigrees.
6. Isolation of genomic DNA from Cauliflower curd.
7. Qualitative analysis of DNA using gel electrophoresis.
8. Estimation of DNA by Diphenylamine method.
9. Separation of nucleotide bases by paper chromatography.
10. Purity and quantitative estimation of isolated DNA by UV-VIS spectrophotometer.
11. Study of Molecular techniques: PCR, Southern, Northern and Western Blotting and PAGE.

Essential/ Recommended readings:

1. Snustad D.P. and Simmon M.J. (2012) *Genetics* 6 th Ed., John Wiley & Sons. (Singapore)
2. PierceB.A, (2012) *Genetics - A Conceptual Approach*, 4 th Ed., W.H. Freeman & Co. (New York)
3. Griffiths A.J.F., Wessler S. R, Carroll S. B and Doebley J. (2010) *An Introduction to Genetic Analysis*, 10th Ed., W.H. Freeman & Company (New York).
4. Watson J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2007) *Molecular Biology of the Gene*, 6th Ed. Pearson Benjamin Cummings, CSHL Press, New York, U.S.A.

Suggestive readings:

1. Klug, W.S., Cummings, M.R. and Spencer, C.A. (2009)*Concepts of Genetics*. 9th Ed. Benjamin Cummings. U.S.A.
2. Russell, P. J. (2010) *Genetics- A Molecular Approach*. 3rd Ed. Benjamin Cummings, U.S.A.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE01)

Course title & Code	Credits	Credit distribution of the core course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Ecology, Conservation and Restoration ALS BOT DSE 01	4	2	0	2	XII pass with Science with Biology/ Biotechnology	NIL

Learning Objectives:

- To develop a scientific understanding of the diverse aspects of ecology.
- To familiarize students with the interactions between the organisms and their physical environment.
- To understand various attributes of populations and communities with the help of theoretical concepts and field studies.
- To make students understand various factors that lead to variations among populations of a species.
- To familiarize students about the concepts of conservation and restoration.

Learning Outcomes:

By studying this course,students will be able to:

- Gain knowledge aboutthebasic concepts of ecology.
- Comprehend the characteristics of the community, ecosystem development and climax theories.
- Explicate the relationship of evolution of various species and their environment.
- Analyse the basic field studies including data collection and its interpretation.
- Explicate the Conservation and Restoration methods.

Unit 1: Introduction to Ecology **(3 Hours)**
Autecology and Synecology, Laws of limiting factors, Study of physical factors: Temperature and Light.

Unit 2: Population **(4 Hours)**
Unitary and Modular populations, Unique and group attributes of population: density, natality, mortality, Life tables, Fecundity table, Survivorship curves, Intraspecific population regulation: density-dependent and independent factors.

Unit 3: Species Interactions **(5 Hours)**
Types of species interactions, Interspecific competition: Lotka-Volterra model of competition, Gause's Principle, Niche concept, Predation, Predator defence mechanisms.

Unit 4: Community **(4 Hours)**
Community characteristics: species richness, dominance, diversity, abundance, guilds, ecotone and edge effect, Ecological succession with examples and types.

Unit 5: Ecosystem **(5 Hours)**

Types of Ecosystems: terrestrial and aquatic ecosystems, Vertical stratification in tropical forest, Food chain: detritus and grazing food chains, linear and Y-shaped food chains, Food web, Energy flow through the ecosystem: Ecological pyramids and Ecological efficiencies, Biogeochemical cycles: Nitrogen cycle.

Unit 6: Conservation (5 Hours)

Ecology in wildlife conservation and management: In-situ conservation (Biosphere Reserves, National Parks, Wildlife Sanctuaries), Ex-situ conservation (botanical gardens, gene banks, seed and seedling banks, DNA banks),Principles of Environmental impact assessment.

Unit 7: Restoration (4 Hours)

Restoration ecology: Afforestation, Social forestry, Agro-forestry, Joint Forest management, Role of remote sensing in management of natural resources.

PRACTICAL (Credit: 02)

(Laboratory practical- 15 classes of 4 hours each)

1. Study of life tables and plotting of survivorship curves of different types from hypothetical/real data.
2. Determination of population density and abundance in a natural or a hypothetical community by quadrat method.
3. Quantitative analysis of herbaceous vegetation in the college campus and comparison with Raunkiaer's Frequency distribution law.
4. Study of morphological features of hydrophytes and xerophytes in the ecosystems.
5. Measurement of temperature, turbidity/penetration of light and pH of any two water samples.
6. Comparison of Dissolved oxygen content in different water samples using Winkler's titration method.
7. Comparison of organic carbon of two soil samples using Walkley and Black's rapid titration method.
8. Comparison of CO_2 and alkalinity in two different water samples.
9. Estimation of Total Dissolved Solids (TDS) in water samples.
10. Perform Rapid field tests to detect the presence of Carbonates, Nitrate, Sulphate, Chloride, Organic matter and Base deficiency in two soil samples.
11. A visit to a National Park/Biodiversity Park/Wildlife Sanctuary/Urban Forest.

Essential/Recommended readings:

1. Sharma, P.D. (2012). *Ecology and Environment*. Rastogi Publications.
2. Singh J.S., Singh S.P., and Gupta S. R. (2014) *Ecology, Environment Science and Conservation*. S. Chand and Company Limited.
3. Odum, E.P. and Barrett G. W. (2004) *Fundamentals of Ecology*. Indian Edition (5th)Brooks/Cole Publishers.

Suggestive readings:

1. Smith T. M. and Smith R. L. (2015). *Elements of Ecology*. 9th International Edition, Publisher: Benjamin Cummings.
2. Saha G.K. and Mazumdar S. (2020) *Wildlife Biology*, An Indian Perspective. Publisher: PHI Learning Private Limited
3. Futuyma, Douglas and Mark, Kirkpatrick (2017). *Evolutionary Biology* (3rd Edition), Oxford University Press

Category IV:
B.Sc. Biological Sciences (Hons)for Undergraduate Programme of study with Botany as a Single Core Discipline

DISCIPLINE SPECIFIC CORE COURSE –9 :						
Course title & Code	**Credits**	**Credit distribution of the core course**			**Eligibility criteria**	**Pre-requisite of the course (if any)**
		Lecture	**Tutorial**	**Practical/ Practice**		
Functional Ecology (BS-DSC303)	**4**	**2**	**-----**	**2**	**Class XII pass with Biology and chemistry, as one of the papers in Class XII**	**Nil**

Learning Objectives

• To understand the basic concepts in ecology and levels of organization in an ecosystem
• Obtain a basic understanding of the various aspects of a 'population' and interactions among individuals of the same as well as different species.
• To understand the structure and functions of the community and its processes.
• To comprehend the components of an ecosystem, energy flow and nutrient cycling.
• To appreciate the applied aspects required in restoration of degraded ecosystems.
• To understand trade-offs in life history characteristics of organisms and various behaviors shownby organisms.

Learning outcomes
By the end of the course, the student will be able to:
• To comprehend the principles and applications of ecology and ecosystem.
• Know about the importance of ecosystem in general and the effects of changes inecosystem.
• Understand the techniques used for the quantitative and qualitative estimation of bioticand abiotic components of an ecosystem.
• Gain knowledge about the density, frequency and diversity of species in an ecosystem.
• Understand about key interactions between organisms like competition , predation ,parasitism etc.
• Participate in citizen science initiatives from an ecological perspective

DISCIPLINE SPECIFIC CORE COURSE –9 :XXX
SYLLABUS OF DSC-9
Theory
Unit 1: Introduction to Ecology **3 Hours**
History of ecology, Autecology and synecology, levels of Organisation, Laws of limiting factors (Liebig's law of minimum, Shelford's law of tolerance), ecological range (Eury and Steno).
Unit 2: Population Ecology **12 Hours**
Population: Unitary and Modular populations; Metapopulation: Density, natality, mortality, life tables, fecundity tables, survivorship curves, sex ratio, age pyramids, dispersal and

dispersion; carrying capacity, population dynamics (exponential and logistic growth equation and patterns), r and K selection, density-dependent and independent population regulation; Niche concept, Population interactions: Positive and negative interactions; Competition, Gause's Principle for competition with laboratory and field examples, Lotka-Volterra equation for predation.

Unit 3: Community Ecology **8 Hours**

Community structure: Dominance, diversity, species richness, abundance, stratification; Diversity indices; Ecotone and edge effect; Community dynamics (succession): Primary and secondary succession, Succession on a bare rock. Climax: monoclimax and polyclimax concepts (preclimax, postclimax, disclimax etc.). Concept of keystone, indicator and flagship species with plant and animal examples.

Unit 4: Ecosystem Ecology **7 Hours**

Concept, components, and types of ecosystems (example of Pond ecosystem in detail showing abiotic and biotic components), BOD, eutrophication. Energy flow (Grazing and Detritus food chain), linear and Y-shaped energy flow model, black box model, food web. Ecological pyramids and Ecological efficiencies.

PRACTICALS CREDITS: 2 **Total 60 Hours**

1. To understand the principle and working of ecological instruments such as Anemometer, Hygrometer, Luxmeter, Rain gauge, turbidity meter, pH meter, Soil thermometer, MinMax thermometer.
2. To study biotic interactions using specimens/ photographs/ permanent slides of Parasitic angiosperms, Saprophytic angiosperms, root nodules, velamen roots, lichens , corals .
3. To study plant-microbe interactions by preparing temporary stained mounts of VAM fungi / mycorrhizal roots/ root nodules.
4. Mark recapture method for determining population density of animals
5. To determine a minimal quadrat area for sampling
6. To determine density, frequency and abundance of herbaceous vegetation by quadrat method
7. To estimate dissolved oxygen content of a given water sample using Winkler's method.
8. Plotting of survivorship curves from hypothetical life table data.XXX

REFERENCES

1. Barrick, M., Odum, E. P., Barrett, G. W., (2005) Fundamentals of Ecology.5th Edition. Cengage Learning.
2. Smith, T. M..& Smith, R. L.(2012). Elements of Ecology 8th Edition. Pearson.
3. Ricklefs, R. E., & Miller, G. L., (2000) Ecology, 4th Edition W.H. Freeman.
4. Sharma, P. D. (2017). Ecology and Environment.13th Edition. Meerut: Rastogi Publications.

MOOCs

1. 'Ecology: Ecosystem Dynamics and Conservation from American Museum of Natural History on Coursera https://www.classcentral.com/course/coursera-ecology- ecosystem-dynamics-andconservation-10618
2. https://alison.com/course/diploma-in-ecology-studies
3. https://swayam.gov.in/ Any ecology based online course that may be available during the semester, depending on its relevance to the present syllabusXXX

DISCIPLINE SPECIFIC Elective –DSE-1 :						
Course title & Code	Credits	Credit distribution of the core course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Medicinal and Ethnobotany (BS-DSE-1)	4	2	-----	2	Class XII pass with Biology and NA chemistry, as one of the papers in Class XII	Nil

Learning Objectives:
Plants are imperative to mankind with almost all plants known to possess medicinal values. There is an increased emphasis on indigenous system of medicine which has lent prime focus on medicinal plants. Keeping the therapeutic importance of medicinal plants in mind this course is designed to provide education and training on diverse perspectives of medicinal plants. The course also offers comprehensive knowledge about understanding the difference between ancient wisdom and themodern system of medicine.

Learning Outcomes:
On successful completion of the course, a student will:
• Be able to identify the common medicinal plants in their vicinity.
• Learn about the traditional healing sciences namely Ayurveda, Siddha and Unani, which have been used since the ancient times.
• Appreciate the importance of conservation strategies for medicinal plants.
• Be able to understand the importance of medicinal plants, significance of ethnobotany, role of ethnic groups in the conservation of medicinal plants.
Course Contents - Theory

Unit 1: History, Scope and Importance of Medicinal Plants No. of Hours-10

Introduction to indigenous systems of medicines- Ayurveda, Unani and Siddha system of medicine)- Ayurveda: History, origin, Panchamahabhutas, Saptadhatu and Tridosha concepts, Siddha: Origin of Siddha medicinal systems, Basis of Siddha system. Unani: History, concept: Umoor-e- tabiya. Plants used in Ayurveda, Siddha and Unani medicine with special reference to Carum carvi, Plantago ovata, Allium sativum, Asparagus racemosus, Vitis vinifera, Linum usitatissimum, Amaranthus paniculatus. Polyherbal formulations (with special reference to Safi, Chyawanprash, Trifala, Swalin, Amukkara Choorna, Gandhak rasayana). Natural products – Compounds responsible for biological activity of medicinal plants: their biology, and pharmacology (Curcumin, Vinblastine, Vincristine, Ecliptine, Cinchonine, Azadirachtin, Artemisinin).

Unit 2: Conservation of Endangered and Endemic Medicinal Plants No. of Hours -8

Definition: endemic and endangered medicinal plants, Red list criteria; In situ conservation: Biosphere reserves, sacred groves, National Parks; Ex situ conservation: Botanical Gardens, herbal gardens, Ethnomedicinal plant gardens. Germplasm conservation, cryopreservation (Cryo banks and DNA banks), Role of NBPGR and JNTBGRI in conservation of plants, Propagation of Medicinal Plants: In vitro and In vivo strategies. Adulteration of Herbal drugs. Organoleptic, microscopic and phytochemical evaluation of plant drugs.

Unit 3: Ethnobotany and Folk Medicines **No. of Hours :12**

Introduction, concept, scope and objectives; Ethnobotany in India: Methods to study ethnobotany; Folk medicines of ethnobotany, Role of ethnobotany in modern medicine with special reference to *Rauvolfia serpentina*, *Trichopus zeylanicus*, *Artemisia, Withania*. Major and minor ethnic groups of India and their lifestyles. Application of natural products to certain diseases- Jaundice, cardiac, infertility, diabetics, blood pressure and skin diseases. Role of ethnic groups in conservation of plant genetic resources; Brief account of biopiracy and IPR.

PRACTICAL
Credit: 2 **Total Hours - 60**

1. Identification of any ten common medicinal plants in the surrounding area and study their characteristic features.
2. Collection, identification and preparation of herbarium of any five medicinal plants.
3. Extraction and qualitative estimation of active principle compounds (alkaloids, tannins, saponins and flavanoids) from any four medicinal plants. (*Aloe vera, Ocimum* sp*, Azadirachta , Catharanthus, Adhatoda, Withania*)
4. Study of components and medicinal uses of common polyherbal formulations used in the traditional system of medicine (Ayurveda, Unani and Siddha).
5. Study of organoleptic, macroscopic and microscopic parameters of any two medicinal plants.
6. To compare the total phenolic content of few locally available medicinal plants
7. Field trip: Industries/Institutes/herbal garden/ medicinal gardens/ nurseries/tribal museum.
8. e-presentations (System of medicine, Conservation strategies, propagation of medicinal plants, folk medicines, application of natural products to certain diseases listed in the syllabus)

Essential readings:

1. Abdin, M. Z. and Abrol, Y. P., (2006). Traditional Systems of Medicine. Narosa Publishing House, New Delhi.
2. Kumar, S., (2018). Ethnobotany. Kojo press, New Delhi.
3. Purohit and Vyas, (2008). Medicinal Plant Cultivation: A Scientific Approach, Agrobios.
4. Trivedi, P. C. (2006). Medicinal Plants: Ethnobotanical Approach. Agrobios.

Additional Readigs

1. Colton, C. M., (1997). Ethnobotany: Principles and Applications. John Wiley and Sons.
2. Jain, S. K., (1990). Contributions to Indian Ethnobotany. Scientific publishers, Jodhpur.
3. Jain, S. K., (1995). Manual of Ethnobotany. Scientific Publishers, Jodhpur.

COMMON POOL OF GENERIC ELECTIVES (GE)

GENERIC ELECTIVES (GE-11): Industrial and Environmental Microbiology

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical / Practice		
Industrial and Environmental Microbiology **GE-11**	4	2	0	2	Class XII pass	Nil

Learning Objectives:

- To introduce students to understand the uses of microbes in industry: concepts, principles, scope and applications.
- To introduce students to the role of microbes in the environment: concepts, principles, scope and application.

Learning Outcomes:

Upon successful completion of the course, students will be able to:

- understand how microorganisms are involved in the manufacture of industrial products.
- know about design of bioreactors, factors affecting growth and production of bioproducts.
- understand the rationale in medium formulation & design for microbial fermentation, sterilization of medium and air.
- comprehend the different types of fermentation processes and the underlying principles in upstream and down- stream processing.
- learn the occurrence, abundance, distributionandrole of microorganisms in the environment.Also, learn different methods for microbial isolation and detection from different habitats.
- understand the basic principles of environmental microbiology and their application in waste water treatment, bioremediation and role of microbes in agriculture.

Unit 1: Introduction **4 hours**

Scope and importance of microbes in Industry and Environment (Institutes of microbial research). Bioremediation. Distribution and isolation of microbes in the air, soil and water.

Unit 2: Bioreactors/ Fermenters and Fermentation process **4 hours**
Solid-state and liquid state (stationary and submerged) fermentations; batch and continuous fermentations; components of a typical bioreactor, types of bioreactors.

Unit 3: Microbial production of industrial importance **12 hours**
Microorganisms generally regarded as safe (GRAS), types of media, conditions necessary for the growth and production of industrially important products, downstream processing and uses; filtration, centrifugation, cell disruption, solvent extraction, precipitation and ultrafiltration, lyophilization, spray drying.
Production of enzyme (amylase); organic acid (citric acid); alcohol (ethanol); antibiotic (penicillin).

Unit 4: Enzyme immobilization **3 hours**
Definition, Methods of immobilization, their advantages and applications, large scale production and application of penicillin acylase.

Unit 5: Microbial flora of water **4 hours**
Microorganisms as indicators of water quality: coliform and faecal coliform; role of microbes in sewage and waste water treatment system.

Unit 6: Microbes and agriculture **3 hours**
Legume root nodule symbiosis, Mycorrhizae, Arbuscular Mycorrhiza Fungi (AMF) and its importance in agriculture.

Practicals: **60 hours**

1. Principle and functioning of instruments in microbiological laboratory (autoclave, laminar flow, incubator, fermenters).
2. Sterilization methods: Wet and dry methods, membrane filters, chemicals.
3. Preparation of different culture media (Potato dextrose agar/Czapek-Dox agar, Luria Bertani) for isolation of microorganisms from soil using serial dilution agar plating method and study of aero-microflora.
4. Culturing techniques: Streak plate method, pour plate method and spread plate method.
5. To study the ability of microorganisms to hydrolyse casein/ starch.
6. Production of alcohol using sugar/ jaggery.
7. Observation of AMF colonization in plant roots.
8. A visit to any educational institute/ industry to understand the uses of microbes for industrial applications and a report to be submitted for the same.

Suggested Readings:

1. Pelczar, M.J. Jr., Chan E.C. S., Krieg, N.R. (2010). Microbiology: An application based approach. New Delhi, Delhi: McGraw Hill Education Pvt. Ltd., Delhi.
2. Reed, G. (2004). Prescott and Dunn's Industrial Microbiology. 4^{th}Edition , CBS Publishers and Distributors Pvt. Ltd.
3. Willey, J.M. (2023). Prescott's Microbiology, 12^{th} edition, McGrew Hill.
4. Tortora, G.J., Funke, B.R., Case. C.L. (2007). Microbiology. 9th edition, San Francisco, SF: Pearson Benjamin Cummings.
5. Stanbury, P.F., Whitaker, A., Hall, S.J. (2017). Principles of Fermentation Technology. Amsterdam, NDL: Elsevier Publication
6. Patel, A.H. (2008). Industrial Microbiology, Bangalore, India: McMillan India Limited
7. Mohapatra. P.K. (2008). Textbook of Environmental Microbiology New Delhi, Delhi, I.K. International Publishing House Pvt. Ltd.
8. Bertrand, Jean-Claude, Caumette, P. Lebaron, P, Matheron, R., Normand, P., Sime Ngando, T. (2015). Environmental Microbiology: Fundamentals and Applications. Amsterdam, Netherlands, Springer.
9. Casida, J.R. (2019). Industrial Microbiology, 2^{nd} Edition, New Age International Publishers, New Delhi.
10. Atlas, R.M., Bartha, R. (2009). Microbial Ecology: Fundamentals and Applications., Pearson, San Francisco
11. Sharma, P.D. (2005). Environmental Microbiology. Meerut, UP: Alpha Science International, Ltd.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVES (GE-12)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Environmental Biotechnology & Management **GE-12**	**4**	**2**	**0**	**2**	Class XII pass	**Nil**

Learning Objectives:
The course aims to build awareness of:
- various global and regional environmental concerns due to natural causes and/or human activities.
- different types of pollution and their impacts on the environment.
- existing and emerging technologies that are important in the area of environmental biotechnology to fulfill Sustainable Development Goals.

Learning Outcomes:
After completion of course the student will be able to:
- demonstrate awareness about emerging concerns such as climate change, waste management; biodegradation of xenobiotic compounds; bioremediation, etc.
- relate applications of biotechnology for alleviating the environmental concerns
- appreciate the scientific, ethical and/or social issues
- understand the national and international legislations, policies and role of public participation in Environmental Protection

Unit 1: Environment **5 hours**
Basic concepts and issues, global environmental problems - ozone layer depletion, UV-B, greenhouse effect and acid rain due to anthropogenic activities, their impact and biotechnological approaches for management. Fate of pollutants in the environment, Bioconcentration, Biomagnification.

Unit 2: Microbiology of waste water treatment 7 hours

Aerobic process - activated sludge, oxidation ponds, trickling filter. Anaerobic process - anaerobic digestion, anaerobic filters, up-flow anaerobic sludge blanket reactors. Treatment schemes for waste waters of dairy and sugar industries.

Unit 3: Xenobiotic compounds 7 hours

Organic (Bio degradation of petroleum products and pesticides) and inorganic (metals, phosphates, nitrates). Bioremediation of xenobiotics in environment - ecological consideration, Bioaccumulation and Biosorption of metals

Unit 4: Treatment of toxic compounds: Role of immobilized cells/enzymes, microbial remediation 5 hours

Biopesticides, bioreactors, bioleaching, biomining, biosensors, biotechniques for air pollution abatement and odour control. Bioindicators and Bioprospecting

Unit 5: International Legislations, Policies for Environmental Protection 3 hours
Stockholm Conference (1972) and its declaration, WCED (1983) and Brundtland Report (1987), Rio Earth Summit-UNCED (1992) and its declaration, Montreal Protocol - 1987, Kyoto Protocol- 1997. Environmental ethics

Unit 6: National Legislations, Policies for Pollution Management 3 hours
Water Pollution (Prevention and Control) Act-1974, Air Pollution (Prevention and Control) Act-1981, National Environmental Policy - 2006, Central and State Pollution Control Boards: Constitution and power.

Practicals: 60 hours

1. To determine the pH and total hardness of water samples collected from different places (polluted and non-polluted sites)
2. To determine the salinity of water samples (polluted and non-polluted sites)
3. To determine the dissolved oxygen of two water samples.
4. To determine the alkalinity of water samples.
5. To determine the pH and rapid field test of soil samples (Chloride, Nitrate, and Sulphate).
6. To study microbessuspended in air and water samples.
7. A visit to any educational institute/ industry to understand the uses of microbes in environmental management and a report to be submitted for the same.

Suggested Readings:

1. De, A. K. (2022). Environmental Chemistry, 10th Edition, New Delhi. New Age International Pvt. Limited
2. Dennis, A., Seal, K.J., Gaylarde, C.C. (2004). Introduction to Biodeterioration, Cambridge University Press
3. Ahmed, N., Qureshi, F.M., Khan, O.Y. (2006). Industrial and Environmental Biotechnology, Horizon Press
4. Rochelle, P.A. (2001). Environmental Molecular Biology, Horizon Press.
5. Jadhav, H.V., Bhosale, V.M. (2015). Environmental Protection and Laws, Himalaya publishing House Pvt Ltd.
6. Trivedi, P. C. (2006). Biodiversity Assessment and Conservation, Agrobios Publ.
7. Rana, S.V.S. (2015). Environmental Biotechnology, Rastogi Publications, India.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVES (GE-13): Plant Biotechnology

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical / Practice		
Plant Biotechnology GE-13	**4**	**2**	**0**	**2**	Class XII pass	**Nil**

Learning Objective

To give students knowledge of techniques used in plant biotechnology and its applications.

Learning Outcomes:

After completion of this course, students will be able to:

- understand the basic concepts, principles, and methods in plant biotechnology.
- will be able to explain the usage of the acquired knowledge in biotechnological, pharmaceutical, medical, ecological, and agricultural applications.

Unit 1: Introduction and Scope of Plant Biotechnology 2 hours

Historical perspective, Current paradigms in plant biotechnology, GM crops, International/National institutions

Unit 2: Plant Tissue Culture 10 hours

Plasticity and Totipotency of plant cells – why and how do plants grow from a single cell; Nutrient media and role of vitamins and hormones. Regeneration of plants in the laboratory: Direct and indirect organogenesis, somatic embryogenesis; Brief account of micropropagation, haploids, triploids and cybrids and their applications; artificial seeds

Unit 3:Cloning and transformation techniques 10 hours

What is cloning?; Restriction and modifying enzymes, plasmids as cloning vehicles, Transformation of bacterial cells, selection of transformants and clones – antibiotic selection, blue-white selection; How do we make transgenic plants: *Agrobacterium*-mediated transformation, Direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment. Selection of transgenic plants - selectable marker and reporter genes (Luciferase, GUS, GFP).

Unit 4: Applications 8 hours

Applications of transgenic plants in enhancing crop productivity: Pest resistant (Bt-cotton, Bt Brinjal) and herbicide resistant plants (Round Up Ready soybean);

Transgenic crops with improved quality traits (FlavrSavr tomato, Golden rice); Improved horticultural varieties (Moondust carnations); Role of transgenics in bioremediation (Superbug), Edible vaccines; Genetically engineered products - Human Growth Hormone and Humulin; Transgenic plants and their role in understanding plant biology, Biosafety regulations for transgenic plants.

Practicals **60 hours**

1. a. Preparation of Murashige & Skoog's (MS) medium.
   b. Demonstration of in vitro sterilization and inoculation methods using leaf and nodal explants of *Nicotiana* / *Datura / Brassica*.
2. Study anther, embryo, endosperm culture, micropropagation and somatic embryogenesis (photographs/slides).
3. Study isolation of protoplasts and production of artificial seeds.
4. Study methods of gene transfer: A*grobacterium*-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment (through digital resources).
5. Study various steps of genetic engineering for production of *Bt*cotton, Golden rice, Flavr Savr tomato.
6. Plasmid and genomic DNA isolation, Restriction digestion and agarose gel electrophoresis of DNA.
7. Visit to a plant tissue culture / Biotechnology laboratory and to submit a field report.

Suggested Readings:

1. Bhojwani, S.S., Bhatnagar, S.P. (2015). The Embryology of Angiosperms, 6th edition. New Delhi, Delhi: Vikas Publication House Pvt. Ltd.
2. Bhojwani, S.S., Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Amsterdam, Netherlands: Elsevier Science.
3. Newmann, Karl-Hermann (2020). Plant Cell and Tissue Culture: A Tool in Biotechnology, 2nd Edition {Springer}
4. Glick, B.R., Pasternak, J.J. (2022). Molecular Biotechnology Principles and Applications of Recombinant DNA, 6th Edition. Washington, U.S.: ASM Press.
5. Stewart, C.N. Jr. (2016). Plant Biotechnology and Genetics: Principles, Techniques and Applications, 2nd Edition. New Jearsey, U.S.: John Wiley & Sons Inc.

Additional Resources:

1. Razdan, M. K. (2019). Introduction to Plant Tissue Culture, 3rd Edition {CBS / Oxford & IBH}
2. Singh, B. D. (2022). Plant Biotechnology, Delhi, Medtech

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVES (GE-14): Plant Tissue Culture

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Plant Tissue Culture **GE-14**	4	**2**	**0**	2	Class XII pass	**Nil**

Learning Objectives

To give students knowledge of techniques used in plant tissue culture and its applications.

Learning Outcomes

The successful students will be able to:

- learn the basic concepts, principles and processes in plant cell and tissue culture.
- understand the use of tissue culture techniques in plant improvement.
- apply the concepts and principles of plant cell and tissue culture in biotechnological and agricultural fields.
- become an entrepreneur by establishing their own plant tissue culture lab.

Unit 1 Introduction **3 hours**

Historical perspective, Important contributions of Haberlandt, White, Reinert & Steward, Murashige, Skoog, Cocking, Guha & Maheshwari, Morrel & Martin.

Terminologies: Cell culture,organ culture, explant, callus, totipotency, plasticity, regeneration, somaclonal variants.

Unit 2 Types and composition of Media **4 hours**

Role of nutrients, vitamins, hormones and supplements in nutrient medium. Composition of MS and White medium.

Unit 3 Techniques of Plant Tissue Culture **4 hours**

Collection of plant material, sterilization of tissue (maintenance of aseptic conditions by use of autoclave and laminar flow chamber), filter sterilization, inoculation.

Unit 4 Protoplast culture **5 hours**

Protoplast isolation (mechanical and enzymatic), culture, purification (viability test) and fusion (spontaneous, induced), selection of fused protoplasts, applications.

Unit 5Micropropagation **5 hours**

Selection of plant material and suitable explant, methodology, plant regeneration pathways-somatic embryogenesis, organogenesis, difference between somatic and zygotic embryos.

Unit 6 Tissue culture applications **9 hours**

Anther culture, Production of haploids, triploids and cybrids, artificial seeds (production & advantages), embryo rescue, virus elimination, secondary metabolite production; Cryopreservation; Germplasm conservation. Novel sources of variation.

Practicals **60 hours**

l. To study the equipment used in tissue culture: autoclave and laminar air flow chamber.
2. Preparation of Murashige & Skoog's (MS) medium.
3. Demonstration of sterilization and inoculation methods using leaf and nodal explants of tobacco, carrot, *Datura*, *Brassica* etc. (any two).
4. Study of anther, embryo and endosperm culture.
5. Study of micropropagation, somatic embryogenesis & artificial seeds.
6. Isolation of protoplasts.
7. Visit to a plant tissue culture laboratory and submission of field report.

Suggested Readings:

1. Bhojwani, S.S. (1990). Plant Tissue Culture: Applications and Limitations {Elsevier}
2. Bhojwani, S.S, Bhatnagar, S.P. (2015). The Embryology of Angiosperms, 6th edition. New Delhi, Delhi: Vikas Publication House Pvt. Ltd.
3. Bhojwani, S. S. and Dantu, P. K. (2013). Plant Tissue Culture: An Introductory Text Springer
4. Bhojwani, S. S. and Razdan, M. K. (1996). Plant Tissue Culture: Theory and Practice, Revised Edition, Elsevier
5. Newmann, Karl-Hermann (2020). Plant Cell and Tissue Culture: A Tool in Biotechnology, 2nd Edition Springer

Additional Resources:

1. Park, Sunghun (2021). Plant Tissue Culture: Techniques and Experiments, 4th Edition Elsevier
2. Razdan, M. K. (2019). Introduction to Plant Tissue Culture, 3rd Edition CBS / Oxford & IBH
3. Smith, R. H. (2013). Plant Tissue Culture: Techniques and Experiments, 3rd Edition {Elsevier}
4. Stewart, C. Neal (2016). Plant Biotechnology and Genetics, 2nd Edition Wiley-Blackwell
5. Trigiano, R. N. (2011). Plant Tissue Culture, Development, and Biotechnology CRC Press

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

GENERIC ELECTIVES (GE-15): Inheritance in Biology

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Inheritance in Biology **GE-15**	**4**	**2**	**0**	2	Class XII pass	**Nil**

Learning Objectives:

- Mendelian and non-Mendelian inheritance: How is genetic information transferred across generations?
- Genetic defects in humans: Causes, inheritance and diagnostics
- Mutations: Types and agents
- DNA fingerprinting: DNA as a tool for establishing unique identity

Learning Outcomes:

Students will get familiarized with the concepts and principles of inheritance, sex determination, causal agents of genetic changes (mutations) and defects (congenital diseases) in humans. The course will also enable students to learn how genetic information is used to detect diseases and also to establish unique identity of an individual.

Section A: Information transfer across generations: Transmission Genetics

Unit 1: Chromosomal Inheritance **7 hours**

Principles of Mendelian inheritance; Chromosomal theory of inheritance, Incomplete dominance and co- dominance; Multiple allelism; lethal alleles; Epistasis; Pleiotropy; Penetrance and expressivity; Polygenic inheritance; Linkage and crossing over.

Unit2: Extra-chromosomal Inheritance: **4 hours**

Chloroplast Inheritance: Variegation in Four O` clock plant; Mitochondrial inheritance: petite mutants in yeast; Maternal effect- shell coiling in snails.

Section B: Male or Female? What determines the gender of the offspring?

Unit 3: Sex determination **3 hours**

Mechanism of sex determination in Insects (*Drosophila*), Plants (*Melandrium, Coccinia*)and humans (Sex determination regions/genes-TDF, SRY and Testicular feminisation), Dosage compensation in humans.

Section C: Human Genetics

Unit 4: Genetic defects-Structural **3 hours**

Autosomal and sex linked, congenital defects: Hemophilia, Thalassemia, Sickle cell anemia, Phenylketonuria, Cystic fibrosis, pedigree analysis

Unit 5: Genetic Defects-Variation in Chromosome number **3 hours**
Syndromes associated with chromosomal abnormalities: Down, Turner, Klinefelter, Edward and Patau.

Section D: Molecular Genetics
Unit 6: Heritable changes (mutations) and their causes **3 hours**
Physical and chemical mutagens, Transposable genetic elements and their role in mutations.

Unit 7: Diagnostics for human genetic disorders **3 hours**
Molecular, chromosomal and biochemical testing

Unit 8: DNA fingerprinting as molecular signatures- applications **4 hours**
Forensics (case studies), Paternity testing, unique identity establishment, conservation, finding adulterants in food/drugs.

Practicals **60 hours**
1. To understand the genetic interaction involved using the given seed mixture. Genetic ratios to be calculated using Chi square analysis.
2. Pedigree analysis (Sex linked dominant and recessive; autosomal dominant and recessive)
3. To study/list human dominant and recessive traits and to observe the listed physical traits among the students present in the class. Analyse the results.
4. To study the syndrome through photographs (Klinefelter, Turner, Downs /Patau/Edwards)
5. To demonstrate variation in the ability to taste PTC (Phenylthiocarbamide) in a given population.
6. Chromosomal and gene mutations: Complex translocation ring, quadrivalents, lagging chromosomes, dicentric/inversion bridge, sickle cell anaemia, xeroderma pigmentosum
7. To study sex chromosomes in *Drosophila, Melandrium, Coccinia* and human through photographs.

Suggested Readings:
1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (1991). Principles of Genetics, 8th edition. New Delhi, Delhi: John Wiley & sons.
2. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2020). Introduction to Genetic Analysis, 12th edition. New York, NY: W.H. Freeman and Co.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2020). Concepts of Genetics, 12th edition. San Francisco, California: Benjamin Cummings.
4. Campbell, N.A., Urry,L.A., Cain, M.L., Wasserman,S.A., Minorsky, P.V., Reece, J.B. (2020). Biology, 12th Edition. Harlow,England : Pearson

Additional Resources:
1. Hartl, D.L., Ruvolo, M. (2019). Genetics: Analysis of Genes and Genomes, 9th edition. New Delhi, Delhi: Jones and Bartlett Learning.
2. Snustad, D.P., Simmons, M.J. (2019). Principles of Genetics, 67th edition. New Delhi, Delhi: John Wiley & sons.
3. Singh, B. D. (2023). Fundamentals of Genetics, 6th edition. MedTech.

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SWAMI SHRADDHANAND COLLEGE

Bachelor of Science (Hons.) in Applied Life Sciences with
Agrochemicals and Pest Management

Botany Component

DISCIPLINE SPECIFIC CORE COURSE (DSC 03)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the core course			Eligibility criteria	Pre-requisite of the course (If any)
		Lecture	Tutorial	Practical/ Practice		
Genetics and Molecular Biology ALS BOT DSC 03	4	2	0	2	XII pass with Science with Biology/ Biotechnology	NIL

Learning Objectives:

The learning objectives of this course are as
follows:

- To understand the basic concept of Mendelian genetics and comprehensive study of Mendelian extensions.
- To provide adequate knowledge about Linkage, Crossing over and Mutations.
- To provide brief knowledge of population and evolutionary genetics.
- To impart detailed understanding about the structure of nucleic acids and their types.
.
- To understand key events of Molecular biology comprising mechanism of DNA Replication, Transcription and Translation in Prokaryotes and Eukaryotes.
- To give comprehensive explanation of Transcriptional Regulation with examples of lac operon and tryptophan operon in prokaryotic as well as eukaryotic organisms along with the key concept of Gene Silencing.

Learning Outcomes:

By studying this course, students will be able to:

- Analyse the basic concepts of Mendelian genetics and its extension, Linkage and Crossing over, Mutations and population genetics.
- Explicate the mechanism of replication, transcription, translation in prokaryotes and eukaryotes.
- Comprehend the mechanism of gene regulation and gene silencing.

Unit 1: Mendelian Genetics and Extensions **(3 Hours)**

Mendel's work on transmission of traits, Co-dominance, Incomplete dominance, Multiple alleles, Lethal Genes, Epistasis, Pleiotropy, Polygenic inheritance, Pedigree analysis.

Unit 2: Extra-chromosomal Inheritance **(2 Hours)**

Cytoplasmic inheritance: Chloroplast variegation in Four 'O clock plant, Kappa particles in *Paramecium*, Maternal effect - shell coiling pattern in snail.

Unit 3: Linkage, Crossing over and Chromosomal Mapping **(3 Hours)**

Linkage and crossing over, Recombination mapping - two point and three points.

Unit 4: Mutations **(3 Hours)**

Chromosomal mutations, Deletion, Duplication, Inversion, Translocation, Aneuploidy and Polyploidy, Gene mutations.

Unit 5: Population and Evolutionary Genetics **(2 Hours)**

Allelic frequencies, Genotypic frequencies, Gene pool, Hardy-Weinberg Law.

Unit 6: The Genetic Material: DNA and RNA **(4 Hours)**

DNA structure: Salient features of double helix, Types of DNA, DNA denaturation and renaturation, Nucleosome, Chromatin structure- Euchromatin, Heterochromatin (Constitutive and Facultative), RNA structure and its types.

Unit 7: Replication of DNA **(3 Hours)**

Mechanism of prokaryotic DNA replication, Chemistry of DNA synthesis, Enzymes and proteins involved in DNA replication, Comparison of replication in prokaryotes and eukaryotes.

Unit 8: Transcription and Processing of RNA **(4 Hours)**

Mechanism of transcription in prokaryotes and eukaryotes, Split genes: concept of introns and exons, Removal of introns, Spliceosome machinery group I & group II intron splicing, alternative splicing, eukaryotic mRNA processing (5' cap, 3' poly A tail).

Unit 9: Translation **(3 Hours)**

Mechanism of translation in prokaryotes and eukaryotes: initiation, elongation and termination of polypeptides, Proteins and enzymes involved in translation.

Unit 10: Regulation of transcription in prokaryotes and eukaryotes **(3 Hours)**

Prokaryotes: Regulation of lactose metabolism and tryptophan synthesis in *E. coli*, Eukaryotes: Transcription factors, Heat shock proteins, Gene silencing.

PRACTICAL **(Credit: 02)**

(Laboratory practical- 15 classes of 4 hours each)

1. To study Mendelian and Non- Mendelian gene interaction ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4) through seeds.
2. To study linkage, recombination, gene mapping using marker-based data from *Drosophila*.
3. Karyotype and Idiogram preparation through photographs.
4. PTC testing in a population and calculation of allelic and genotypic frequencies.
5. Study of abnormal human karyotype and pedigrees.
6. Isolation of genomic DNA from Cauliflower curd.
7. Qualitative analysis of DNA using gel electrophoresis.
8. Estimation of DNA by Diphenylamine method.
9. Separation of nucleotide bases by paper chromatography.
10. Purity and quantitative estimation of isolated DNA by UV-VIS spectrophotometer.
11. Study of Molecular techniques: PCR, Southern, Northern and Western Blotting and PAGE.

Essential/ Recommended readings:

5. Snustad D.P. and Simmon M.J. (2012) *Genetics* 6 th Ed., John Wiley & Sons. (Singapore)
6. Pierce B.A, (2012) *Genetics - A Conceptual Approach*, 4 th Ed., W.H. Freeman & Co. (New York)

7. Griffiths A.J.F., Wessler S. R, Carroll S. B and Doebley J. (2010) *An Introduction to Genetic Analysis*, 10th Ed., W.H. Freeman & Company (New York).
8. Watson J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2007) *Molecular Biology of the Gene*, 6th Ed. Pearson Benjamin Cummings, CSHL Press, New York, U.S.A.

Suggestive readings:

3. Klug, W.S., Cummings, M.R. and Spencer, C.A. (2009) *Concepts of Genetics*. 9th Ed. Benjamin Cummings. U.S.A.
4. Russell, P. J. (2010) *Genetics- A Molecular Approach*. 3rd Ed. Benjamin Cummings, U.S.A.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE 01)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the core course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Ecology, Conservation and Restoration ALS BOT DSE 01	4	2	0	2	XII pass with Science with Biology/ Biotechnology	NIL

Learning Objectives:

The learning objectives of this course are as follows:

- To develop a scientific understanding of the diverse aspects of ecology.
- To familiarize students with the interactions between the organisms and their physical environment.
- To understand various attributes of populations and communities with the help of theoretical concepts and field studies.
- To make students understand various factors that lead to variations among populations of a species.
- To familiarize students about the concepts of conservation and restoration.

Learning Outcomes:

By studying this course, students will be able to:

- Gain knowledge about the basic concepts of ecology.
- Comprehend the characteristics of the community, ecosystem development and climax theories.
- Explicate the relationship of evolution of various species and their environment.
- Analyse the basic field studies including data collection and its interpretation.
- Explicate the Conservation and Restoration methods.

Unit 1: Introduction to Ecology **(3 Hours)**

Autecology and Synecology, Laws of limiting factors, Study of physical factors: Temperature and Light.

Unit 2: Population (4 Hours)

Unitary and Modular populations, Unique and group attributes of population: density, natality, mortality, Life tables, Fecundity table, Survivorship curves, Intraspecific population regulation: density-dependent and independent factors.

Unit 3: Species Interactions (5 Hours)

Types of species interactions, Interspecific competition: Lotka-Volterra model of competition, Gause's Principle, Niche concept, Predation, Predator defence mechanisms.

Unit 4: Community (4 Hours)

Community characteristics: species richness, dominance, diversity, abundance, guilds, ecotone and edge effect, Ecological succession with examples and types.

Unit 5: Ecosystem (5 Hours)

Types of Ecosystems: terrestrial and aquatic ecosystems, Vertical stratification in tropical forest, Food chain: detritus and grazing food chains, linear and Y-shaped food chains, F ood web, Energy flow through the ecosystem: Ecological pyramids and Ecological efficiencies, Biogeochemical cycles: Nitrogen cycle.

Unit 6: Conservation (5 Hours)

Ecology in wildlife conservation and management: In-situ conservation (Biosphere Reserves, National Parks, Wildlife Sanctuaries), Ex-situ conservation (botanical gardens, gene banks, seed and seedling banks, DNA banks), Principles of Environmental impact assessment.

Unit 7: Restoration (4 Hours)

Restoration ecology: Afforestation, Social forestry, Agro-forestry, Joint Forest management, Role of remote sensing in management of natural resources.

PRACTICAL (Credit: 02)

(Laboratory practical- 15 classes of 4 hours each)

12. Study of life tables and plotting of survivorship curves of different types from hypothetical/real data.
13. Determination of population density and abundance in a natural or a hypothetical community by quadrat method.
14. Quantitative analysis of herbaceous vegetation in the college campus and comparison with Raunkiaer's Frequency distribution law.
15. Study of morphological features of hydrophytes and xerophytes in the ecosystems.
16. Measurement of temperature, turbidity/penetration of light and pH of any two water samples.

17. Comparison of Dissolved oxygen content in different water samples using Winkler's titration method.
18. Comparison of organic carbon of two soil samples using Walkley and Black's rapid titration method.
19. Comparison of CO_2 and alkalinity in two different water samples.
20. Estimation of Total Dissolved Solids (TDS) in water samples.
21. Perform Rapid field tests to detect the presence of Carbonates, Nitrate, Sulphate, Chloride, Organic matter and Base deficiency in two soil samples.
22. A visit to a National Park/Biodiversity Park/Wildlife Sanctuary/Urban Forest.

Essential/Recommended readings:

4. Sharma, P.D. (2012). *Ecology and Environment*. Rastogi Publications.
5. Singh J.S., Singh S.P., and Gupta S. R. (2014) *Ecology, Environment Science and Conservation*. S. Chand and Company Limited.
6. Odum, E.P. and Barrett G. W. (2004) *Fundamentals of Ecology*. Indian Edition (5th) Brooks/Cole Publishers.

Suggestive readings:

4. Smith T. M. and Smith R. L. (2015). *Elements of Ecology*. 9th International Edition, Publisher: Benjamin Cummings.
5. Saha G.K. and Mazumdar S. (2020) *Wildlife Biology*, An Indian Perspective.Publisher: PHI Learning Private Limited
6. Futuyma, Douglas and Mark, Kirkpatrick (2017). *Evolutionary Biology* (3rd Edition), Oxford University Press

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CHEMISTRY COMPONENT

DISCIPLINE SPECIFIC CORE COURSE (DSC 03)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Organic Chemistry; ALS CHEM DSC 03	4	2	0	2	XII pass with Science with Biology/ Biotechnology	NIL

Learning Objectives:

The Learning Objectives of this course are as follows:

- To teach the fundamentals of organic chemistry.
- To introduce the basic concepts of stereochemistry of organic molecules.
- To familiarize students to different types of organic reactions.
- To inculcate the basics of reaction mechanism through different reactive intermediates.

Learning Outcomes:

By studying this course, students will be able to:

- Explain the relative behavior of organic compounds based on fundamental concepts learnt.
- Illustrate the mechanism of organic reactions by recalling and correlating the fundamental properties of the reactants involved.
- Differentiate between various types of organic reactions possible on the basis of reaction conditions.

Unit 1: Basic Concepts **(6 Hours)**

Electronic displacements and their applications: Inductive, electromeric, resonance (mesomeric) effects and hyperconjugation. Dipole moment, acidic and basic behaviour of organic molecules.
Homolytic and heterolytic fission. Types, shape and relative stability of carbocations, carbanions and free radicals. Electrophiles and nucleophiles.

Unit 2: Stereochemistry **(10 Hours)**

Stereoisomerism: Concept of asymmetry and Optical activity, Chirality in molecules with one and two stereocentres. Fischer projection, enantiomers, diastereomers and meso structures. Specific rotation.

Configuration: CIP rules: Erythro/Threo, D/L and R/S designations.
Geometrical isomerism: *cis-trans, syn-anti* and *E/Z* notations.
Conformational Isomerism: Newmann, Sawhorse, Fischer and their interconversion.
Conformations, relative stability and energy diagrams of Ethane, Propane and butane. Relative stability of cycloalkanes (Baeyer strain theory), Cyclohexane conformations with energy diagram. Conformations of monosubstituted cyclohexanes.

Unit 3: Types of Organic Reactions **(10 Hours)**

Introduction to substitution, addition, elimination, rearrangement, oxidation and reduction reactions.
Nucleophilic substitution reactions-SN1 and SN2 mechanisms with stereochemical aspects and effect of solvent.
Elimination reactions: E1 and E2 mechanisms, Saytzeff, Hoffmann eliminations and Cope elimination. nucleophilic substitution vs. elimination.
Free radical substitutions: Halogenation of alkanes and concept of relative reactivity and selectivity.
Electrophilic addition reactions of alkenes and alkynes: mechanism with suitable examples, (Markownikov's/anti-Markownikov's addition), syn and anti-addition; addition of hydrogen, halogens, hydroboration-oxidation, ozonolysis and hydroxylation.

Unit 4: Aromaticity **(4 Hours)**

Concept of Aromaticity: Electrophilic aromatic substitutions (with their mechanism): halogenation, nitration, Friedel Crafts alkylation/ acylation, sulphonation. Orientation and reactivity in mono-substituted aromatic compounds.

PRACTICAL **(Credit: 02)**

(Laboratory practical- 15 classes of 4 hours each)

1. Purification of organic compounds by crystallization (from water and alcohol) and distillation.
2. Calibration of thermometer.
3. Criteria of purity: Determination of melting point.
4. Effect of impurity on the melting point.
5. Determination of boiling point of liquid compounds (boiling point lower than and more than 100 °C by distillation and inverse capillary method).
6. Detection of extra elements.

7. Separation of a mixture of two amino acids/sugars by radial/ascending paper chromatography.
8. Preparations (Mechanism of various reactions involved to be discussed):
   a. Bromination of phenol/aniline
   b. Benzoylation of phenol/aniline
   c. Nitration of nitrobenzene/toluene

The above derivatives should be prepared using 0.5-1 g of the organic compound. The solid samples must be collected and may be used for recrystallization and melting point.

Essential/Recommended readings

1. Mehta Bhupinder; Mehta Manju (2015), *Organic Chemistry*, Second Edition, ISBN-978-81-203-5126-4, PHI Learning Pvt. Ltd. New Delhi.
2. Sykes, P.(2003), *A Guide Book to Mechanism in Organic Chemistry*, 6th Edition Pearson Education.
3. Eliel, E. L. (2001), *Stereochemistry of Carbon Compounds*, Tata McGraw Hill.
4. Morrison, R. N.; Boyd, R. N., Bhattacharjee, S.K. (2010), *Organic Chemistry*, 7th Edition, Pearson Education.
5. Bahl, A; Bahl, B. S. (2019), *Advanced Organic Chemistry*, 22nd Edition, S. Chand.

Suggestive readings

1. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. (2012), *Vogel's Textbook of Practical Organic Chemistry*, Pearson.
2. Mann, F.G.; Saunders, B.C. (2009), *Practical Organic Chemistry*, Pearson Education.
3. Dhingra, S; Ahluwalia V.K., (2017), *Advanced Experimental Organic Chemistry*, Manakin Press.
4. Pasricha, S.; Chaudhary, A. (2021), *Practical Organic Chemistry: Volume I*, I K International Publishing House Pvt. Ltd., New Delhi.
5. Singh, J.; Awasthi, S. K.; Singh, Jaya. (2023) *Fundamentals of Organic Chemistry-III*, Pragati Prakashan.

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DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE 01)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Introduction to Heterocyclic Chemistry; ALS CHEM DSE 01	4	2	0	2	XII pass with Science with Biology/ Biotechnology	NIL

Learning Objectives:

The Learning objectives of this course are as follows:

- To teach students the fundamentals of heterocyclic chemistry.
- To make them familiar with classification and nomenclature of heterocyclic compounds.
- To study structural characteristics, physical properties, synthesis and chemical reactions of heterocyclic compounds.
- To know the importance of heterocyclic compounds.

Learning Outcomes:

By studying this course, students will be able to:

- Classify and name heterocyclic compounds.
- Analyze the important synthetic routes, physical properties, chemical properties and reactivity of five and six membered heterocyclic compounds.
- Explain the heterocyclic structures in biologically active compounds.
- Apply the study of heterocyclic compounds in medicine, agrochemicals, dyes and pigments, plastics and polymers.

Unit 1: Introduction and Nomenclature **(4 Hours)**

Introduction and classification of heterocyclic compounds. Nomenclature: Trivial names of common ring systems, Systematic (Hantzsch-Widman) nomenclature for heterocyclic compounds, naming of fused ring systems and Replacement nomenclature.

Unit 2: General Properties and Synthesis of Five and Six Membered Heterocyclic Compounds **(8 Hours)**

General discussion on the following aspects of five and six membered heterocyclic compounds containing one heteroatom: Structure, aromaticity, basicity, physical properties and general methods of synthesis of Furan, Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis, Hantzsch synthesis), Thiophene and Pyridine (Hantzsch synthesis).

Unit 3: Reactions of Five and Six Membered Heterocyclic Compounds (10 Hours)

Furan, Pyrrole, Thiophene: Orientation and reactivity towards electrophilic substitution reactions with mechanism.
Discussion on the following reactions: Nitration, sulphonation, halogenation, formylation, acylation, mercuration and carboxylation. Reactions exhibiting acidic/basic character. Oxidation, reduction and addition reactions. Diels-Alder reaction, reaction with diazonium salt.
Pyridine: Electrophilic substitution, nucleophilic substitution, oxidation and reduction reactions.

Unit 4: Importance of Heterocyclic Compounds (8 Hours)

Structure and importance of the following selected biologically active compounds to be discussed:
Heterocyclic Amino Acids: Proline, Hydroxyproline, Histidine, Tryptophan. Heterocyclic Vitamins; Niacin (Vitamin B3), Pyridoxine (Vitamin B6), Riboflavin (Vitamin B2), Thiamin (Vitamin B1) and Ascorbic acid (Vitamin C).
Pigments of Life: Hemoglobin and Chlorophyll.
Nucleic acids: Ribonucleic Acid (RNA) and Deoxyribonucleic Acid (DNA), Purines and Pyrimidines.

Structure and importance of the following selected Natural Products**:** Alkaloids, Marine Heterocycles, Halogenated Heterocycles, Macrocycles containing Oxazoles and Thiazoles, Anthocyanins and Flavones.

Structure and importance of heterocyclic compounds in Medicine, Agrochemicals, Dyes and pigments, Plastics and polymers.

PRACTICAL (Credit: 02)

(Laboratory practical- 15 classes of 4 hours each)

The following synthesis should be done by using 0.5-1 g of the organic compound. The solid samples must be collected and may be used for recrystallization and melting point.

1. Synthesis of oxygen containing heterocyclic compounds:
   (a) Phthalic anhydride (b) 7- Hydroxy-4-methylcoumarin

2. Synthesis of nitrogen containing heterocyclic compounds:
   (a) Phthalimide (b) Phthaloylglycine
3. Synthesis of Imidazole derivatives:
   (a) Benzimidazole (b) 2-Benzylbenzimidazole (c) 2-Methylbenzimidazole
4. Synthesis of Pyrazole derivatives:
   (a) 3-Methyl-2-pyrazolin-5-one (b) 3, 5-Dimethylpyrazole
5. Synthesis of Pseudothiohydantoin

Essential/Recommended readings

1. Mehta Bhupinder and Mehta Manju (2015) "*Organic Chemistry" 2nd Edn*., PHI Learning Pvt. Ltd. New Delhi. ISBN-978-81-203-5126-4.
2. Bansal Raj K "*Heterocyclic Chemistry" 5th Ed*, New Age International Publishers. ISBN 978-81-224-3143-8.
3. J. A. Joule, K. Mills and G. F. Smith, "*Heterocyclic Chemistry" 5th Edn.,* Wiley International Publications. ISBN: 978-1-4051-3300-5.
4. Thomas. L. Gilchrist "*Heterocyclic Chemistry" 3rd Edn.*, Prentice Hall Publication. ISBN 978-0-5822-7843-1.
5. R. M. Acheson "*An Introduction to the Chemistry of Heterocyclic compounds" 3rd Edn.,* Wiley India Pvt. Ltd. ISBN-13:978-8126516605.
6. I L Finar, "*Organic Chemistry" Vol. 1*, 6th Edn., Pearson Education. ISBN 10: 8177585428.
7. T. W. Graham Solomons, "*Organic Chemistry*" 12th Edn., John Wiley. ISBN-10: 1118133579.
8. Parashar, R. K.; Negi, B., "*Chemistry of Heterocyclic Compounds"*, 2015, Ane Books. ISBN-1466517131.

Suggestive readings

1. A.O. Fitton and R.K. Smalley, "*Practical Heterocyclic Chemistry"* 1st Edn., Academic Press. ISBN:9781483270791.

2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. (2012), "*Vogel's Textbook of Practical Organic Chemistry"*, Pearson.

3. Mann, F.G.; Saunders, B.C. (2009), "*Practical Organic Chemistry*", Pearson.

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ZOOLOGY COMPONENT

DISCIPLINE SPECIFIC CORE (DSC 03)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Cell Biology and Biochemistry ALS ZOO DSC 03	4	2	0	2	XII pass with Science with Biology/ Biotechnology	NIL

Learning Objectives:

The learning objectives of this course are as follows:

- To understand structure and functions of various cellular compartments and cell organelles.
- To learn about cell-cycle and its regulation.
- To acquire the knowledge of biomolecules and metabolic pathways.
- To study about enzyme action.

Learning Outcomes:

By studying this course, students will be able to:

- correlate the structure of various cell components with their function.
- describe the metabolic fate of carbohydrates, proteins and fats and understand the mechanics of enzyme action.

Unit 1: Basic structure of cell and cell organelles (12 Hours)

Prokaryotic and eukaryotic cells. Structure of cell membrane: various models, fluidity of membrane. Eukaryotic cell organelles: Mitochondria, Chloroplast, Endoplasmic reticulum, Golgi body and Lysosomes. Nucleus: Nuclear Envelope- structure of nuclear pore complex, chromatin- euchromatin and heterochromatin; DNA packaging in eukaryotes.

Unit 2: Cell Cycle **(3 Hours)**

Cell division: Mitosis and Meiosis. Regulation of cell cycle.

Unit 3: Biomolecules and Metabolic pathways **(11 Hours)**

Introduction to Biomolecules: Carbohydrates, Lipids, and Proteins. Glycolysis, Kreb's Cycle, Pentose phosphate pathway, Gluconeogenesis, Glycogen Metabolism. β oxidation of palmitic acid. Transamination, Deamination and Urea Cycle.

Unit 4: Enzyme action and regulation **(4 Hours)**

Mechanism of action (induced fit theory), Enzyme Kinetics (Michaelis Menten equation for single enzyme single substrate reactions), Enzyme inhibition and regulation.

PRACTICAL **(Credit: 02)**

(Laboratory practical- 15 classes of 4 hours each)

1. Preparation of a temporary stained squash of onion root tip and to study various stages of mitosis.
2. Study of various stages of meiosis through permanent slides.
3. Cytochemical demonstration of DNA by Feulgen reaction.
4. Perform qualitative tests to identify functional groups of carbohydrates in given solutions (Glucose, Fructose, Sucrose, Lactose)
5. Study of activity of salivary amylase under optimum conditions.
6. Separation and identification of amino acids by paper chromatography

Essential/Recommended readings

1. Becker, Kleinsmith, and Hardin (2018) *The World of the Cell*, IX Edition, BenjaminCummings Publishing, San Francisco.
2. Karp, G. (2015). *Cell and Molecular Biology: Concepts and Experiments*, VIII Edition, John Wiley & Sons Inc.
3. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2015) *Biochemistry*. VII Edition. W.H Freeman and Co.
4. Nelson, D. L., Cox, M. M. and Lehninger, A.L. (2009). *Principles of Biochemistry*. IV Edition. W.H. Freeman and Co.

Suggestive readings

1. Cooper, G.M., Hausman, R.E. (2019) *The Cell: A Molecular Approach*. VIII Edition, ASM Press and Sinauer Associates.
2. Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. (2009). *Harper's Illustrated Biochemistry*. XXVIII Edition. Lange Medical Books/Mc Graw3Hill.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE 01)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Biostatistics and Bioinformatics ALS ZOO DSE 01	4	2	0	2	XII pass with Science with Biology/ Biotechnology	NIL

Learning Objectives:

The learning objectives of this course are as follows:

- To acquaint the students of the application of statistical methods for analysing the biological data.
- To impart the theoretical and practical knowledge of biological databases and use of various software for their analysis.

Learning Outcomes:

By studying this course, students will be able to:

- use statistical formulae for analyzing data.
- apply statistical tests like Chi-square tests, Z-test and t- test etc. for testing hypothesis.
- Use different biological databases and bioinformatic tools.

Unit 1: Introduction to Biostatistics **(2 Hours)**

Definition, Aim and Scope, Applications and limitations of biostatistics.

Unit 2: Measures of Central Tendency and Dispersion **(6 Hours)**

Mean, Median and Mode; Variance, Standard deviation, Standard error, Co-efficient of Variance.

Unit 3: Testing of Hypothesis and Statistical Tests **(7 Hours)**

Type-I and Type-II errors; Confidence Intervals and Confidence Levels, Chi-square test, Z-test and t-test.

Bioinformatics

Unit 4: Introduction to Bioinformatics (3 Hours)

Historical background, Aims and scope, Bioinformatics in Genomics, Transcriptomics, Proteomics, Metabolomics, Systems biology, Applications and Limitations in bioinformatics.

Unit 5: Biological Databases (5 Hours)

Introduction to biological databases; Primary, secondary and composite databases; Nucleic acid databases (GenBank, DDBJ, EMBL and NDB); Protein databases (PIR, SWISS-PROT, TrEMBL, PDB).

Unit 6: Basic Concepts of Sequence Alignment (7 Hours)

Scoring Matrices (PAM, BLOSUM), Methods of Alignment (Dot matrix, Dynamic Programming, BLAST and FASTA); Local and global alignment, pair wise and multiple sequence alignments; Similarity, identity and homology of sequences.

PRACTICAL (Credit: 02)

(Laboratory practical- 15 classes of 4 hours each)

Part - A Biostatistics

1. To compute Coefficient of Variance from samples provided.
2. To collect data on different parameters of animal samples and test significant difference between means (Z-test, t-test).
3. To compute 'test of independence' and test for 'goodness of fit' with samples/data provided.
4. To learn graphical representations of statistical data with the help of computers (e.g. MS Excel).

Part - B Bioinformatics

1. To learn about biological databases and their characteristics.
2. To retrieve nucleotide and protein sequences from the databases.
3. To perform pair-wise alignment of sequences (BLAST).

4. To perform multiple sequence alignment (Clustal X)

Essential/Recommended readings

1. Ghosh Z and Mallick B. (2008). Bioinformatics: *Principles and Applications*, Oxford University Press.
2. Pevsner J. (2009). *Bioinformatics and Functional Genomic*s, II Edition, Wiley Blackwell.
3. Zar, Jerrold H. (1999). *Biostatistical Analysis*, IV Edition, Pearson Education Inc and Dorling Kindersley Publishing Inc. USA

Suggestive readings

1. Zvelebil, Marketa and Baum O. Jeremy (2008. *Understanding Bioinformatics*, Garland Science, Taylor and Francis Group, USA.

2. Antonisamy, B., Christopher S. and Samuel, P. P. (2010). *Biostatistics: Principles and Practice*. Tata McGraw Hill Education Private Limited, India.

3. Pagana, M. and Gavreau, K. (2000). *Principles of Biostatistics,* Duxberry Press, USA

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

B.Sc (H) Biomedical Science

SEMESTER –III

Biomedical Science: ***II Year***

DISCIPLINE SPECIFIC CORE COURSE -7 (BIOMED-DSC-07) MEDICAL MICROBIOLOGY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility Criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Medical Microbiology DSC-07	4	3	0	1	XII Passed	Basic knowledge of biology

Learning objectives

The Learning Objectives of this course are as follows:

- The Medical Microbiology course has been formulated to impart basic and medically relevant information on microbes.
- The microbial structure, growth and development. Methods of isolation and characterization of microbes and role of sterilization in the context of study of microbes.
- Pathogenic microbes and the diseases caused by them are included to broaden the perspective of the subject.
- This course will also focus on mechanisms of microbial pathogenesis and the host response, and the scientific approaches that are used to investigate these processes.
- The course also deals with the problem of emerging antimicrobial resistance with reference to known pathogens.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Medical microbiology describes a broad perspective to study structure, classification, and diseases caused by microbes including bacteria, fungi, protozoa and viruses. The course helps to understand the nature of microorganism, their systematic classification and contribution of various scientists in the discovery of disease causing pathogen and its etiology. It also describes various culture media used for cultivation of microbes, their optimum physical, chemical and cultural requirements, techniques for purification and preservation of microbes.
- This course explains the various types of microbial cells, shape, size, molecular structure and their role in pathogenesis. The basic nutrient requirements of microorganism and how they behave in variable atmospheric conditions is also included. Analyzing optimum growth conditions that facilitate in growth and cultivation of useful microorganisms are also mentioned.
- Microbial genetics helps to understand the basic phenomenon of gene functioning and effects of various mutagens on microorganism, elucidates different methods of gene transfer and explains causes of genetic variation.
- Course also elucidates the interaction between host and their pathogens, mode of transmission of infectious diseases and their cure.
- This course also explains pathogenesis, etiology, clinical symptoms, control and cure of microbial diseases in addition to introducing antimicrobial action of antibiotics. Describes basic structural and morphological variation in various viruses, classification and their life cycle. Introduction to requirements of viruses for multiplication and detailed study of common disease causing viruses, virusoids and prions is also included.

SYLLABUS OF BIOMED-DSC-07

Unit I: Fundamental concepts **(10 hrs)**

a) History of microbiology with special emphasis on contribution of Louis Pasteur and Robert Koch in Medical Microbiology.
b) Major Divisions of life- Domains, Kingdoms; Requirements for microbial growth, growth factors, culture media- synthetic and complex, types of media. Techniques for obtaining pure cultures of microbes, preservation and storage of bacterial cultures, growth curve and generation time, control of microbial growth.

Unit II: Bacterial cell: fine structure and function **(10 hrs)**

Size, shape and arrangement of bacterial cells; Cell membrane, cytoplasmic matrix, inclusion bodies (e.g.Carboxysomes, magnetosomes, gas vacuoles, cyanophycean granules, PHB granules, glycogen granules), nucleoid, ultrastructure of gram positive and gram negative bacterial cell wall, sex pili, capsule, flagella & motility and endospore.

Unit III: Microbial genetics (08 hrs)

Mutants-auxotrophs and prototrophs, bacterial recombination: general and site specific and replicative, bacterial plasmids fertility factor, col plasmid, bacterial conjugation (Hfr, F′, F^+, F^-), transformation, transduction- both generalized and specialized.

Unit IV: Host-pathogen relationship in the infectious diseases (05 hrs)

Relationship between normal microbiota and host, opportunistic microorganisms, nosocomial infections. Development and spread of infectious diseases: invasion, pathogen, parasite, pathogenicity, virulence, carriers and their types. Routes, mechanisms of invasion and establishment of infection.

Unit V: Microbial diseases (06 hrs)

Respiratory tract infections: with tuberculosis in detail, gastrointestinal tract infections, staphylococcal food poisoning. Life cycle of *Candida albicans* and *Plasmodium*.

Unit VI: Virus and virusoids (06 hrs)

General life cycle of a virus, structure, enveloped and un-enveloped viruses, plaque assay, growth curve, classification based on genetic material and detail study of influenza, SARS COV-2 and HIV virus with curative agent. Viroids, virusoids and prions.

Practical (30 hrs)

(Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Preparation of different media: synthetic media Davis-Mingioli media, complex media-nutrient agar or Luria agar media.
2. Isolation and purification of pure bacteria: streaking for single colonies
3. Propagation of pure bacteria in liquid culture
4. Gram's staining; gram positive and gram negative bacteria

5. Capsule staining of *Bacillus subtilis*/*Klebsiella*
6. Endospore staining of *Bacillus subtilis*
7. Study and plotting the growth curve of *E. coli* using turbidometric method
8. Isolation of bacteriophages from soil/sewer water and calculation of the plaque forming units (pfu)
9. To perform antibacterial testing by Kirby-Bauer method
10. Field visit to a clinical microbiology lab/diagnostic lab to familiarize with latest tools and techniques used in microbial research

Essential readings:

- Dorothy Wood, Joanne Willey, Kathleen Sandman (2022). 12th Edition. Prescott's microbiology. New York, USA: McGraw-Hill Education. ISBN-10: 1-264-77733-7 / 1264777337
- Cappuccino, J.G. and Sherman, N. (2013). 10th Edition. Microbiology: A laboratory manual. California, USA: Benjamin Cumming. ISBN-13: 978-0321840226.

Suggestive readings:

- Tille, P. (2013). 13th Edition. Bailey & Scott's diagnostic microbiology. Missouri, USA: Mosby Publishers. ISBN-13: 978-0323083300.
- Madigan, M.T., Martinko, J.M., Stahl, D.A. and Clark, D.P. (2010). 13th Edition. Brock biology of microorganisms. California, USA: Benjamin Cumming. ISBN-13: 978-0321649638.
- Pelczar, M.J (2001). 5th Edition. Microbiology. New York, USA: McGraw Hill International. ISBN-13: 9780074623206.
- Tortora, G.J., Funke, B.R. and Case C.L. (2006). 9th Edition. Microbiology: An introduction. California, USA: Benjamin Cummings. ISBN-13: 978-0536292117.

DISCIPLINE SPECIFIC CORE COURSE -8 (BIOMED-DSC-08) MEDICINAL CHEMISTRY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
MEDICINAL CHEMISTRY DSC-08	**4**	**3**	**0**	**1**	**XII Passed**	**Basic knowledge of Enzymes and proteins**

Learning objectives

The introduction of Medicinal Chemistry course at undergraduate level to Biomedical Science students has been conceived to make them understand:

- Concealed chemical science interlinked to other science disciplines such as biophysics, chemistry, biology, biochemistry, pharmacology etc.
- Application of the area in revealing new drug design and targets through studying the drug-receptor interactions and signaling mechanism in cell for lead discovery.
- Various drug targets in the body and drug development strategies with mechanism of action and concept of drug resistance.

Learning Outcomes

- After completing the course, students shall be able to understand the various stages involved in drug development. Further, they will be able to explore various kinds of drug targets including protein, enzymes, nucleic acids etc.
- They will also appreciate the process of drug-receptor interactions; identify association between chemical structure and its physicochemical properties. After the completion of the course, the learners will demonstrate a strong foundation via problem solving, critical thinking and analytical reasoning in the fundamentals of medicinal chemistry, physicochemical principles of drug action and measurement of drug effects, comprehend the physicochemical basis for the rational drug design, analogue synthesis, and mechanism of action of drugs.
- Additionally, this course will involve extensive laboratory work. The students will be able to

design and carry out small molecule (low molecular drug-relevant compounds) synthesis. They will do the natural product isolation along with their purification and characterization through chromatography and spectroscopic methods and analyze the results of such experiments.

- They will also actively participate group exercises; communicate the results of experiments conducted in oral as well as written formats. Further, they will appreciate the central role of chemistry in our daily life and will also learn safe handling of hazardous chemicals and follow the SOP for chemical waste disposal.

SYLLABUS OF BIOMED-DSC-08

Unit-1: General introduction (02 hrs)

Definition and scope of Medicinal Chemistry

Unit-2: Principles of Drug Design (10 hrs)

Introduction to Structure Activity Relationship (SAR) of morphine/salicylic acid, strategies in the search for new lead compounds, analogue synthesis versus rational drug design, concept of prodrugs. Affinity, efficacy and potency of drugs. Concepts of agonist, antagonist and inverse agonist, competitive, non-competitive, suicide inhibitors.

Unit-3: Physicochemical principles of drug action and measurement of drug effects (10 hrs)

Partition coefficient, drug dissolution, acid-base properties, surface activity, bioavailability, stereochemical aspects of drug action, electronic structure (Hammett correlations) and determining relationship between chemical and biological data (Hansch approach). Kinetic analysis of ligand receptor interactions using Scatchard plot, Double reciprocal plot, Hill plot, forces involved, relationship between dose and effect (graded and quantal response).

Unit-4: Drug target classification (15 hrs)

a. Proteins as drug targets.
   i. Receptors: the receptor role, ion channels, membrane bound enzyme activation, desensitization and sensitization of receptors, agonist (e.g. endorphins) and antagonists(e.g. caffeine)
   ii. Enzymes: Enzyme inhibitors, medicinal use of enzyme inhibitors (e.g. clavulanic acid)

b. Nucleic acids as drug targets. Classes of drugs that interact with DNA: DNA intercalators (amsacrine), Groove binders (netropsin), DNA alkylators (amines: mechlorethamine; nitrosoureas: carmustine), concept of antisense therapy.

Unit-5: How drugs trigger the signals-molecular aspects (08 hrs)

Structure and functions of cell surface receptors, signal transduction mechanism (GPCRs, tyrosine kinase, guanylate-cyclase linked receptors and intracellular receptors that regulate DNA transcription).

Practical (30 hrs)

(Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Preparation, recrystallization and purity of following drugs/compounds by melting point and TLC
   i. Hippuric acid.
   ii. Benzocaine,
   iii. Benzoquinone
   iv. Phenacetin
   v. s-benzyl thiouronium salt.
2. Determination of partition coefficient of aspirin in octanol-water system.
3. Extraction of caffeine from tea leaves.
4. Study absorption properties of caffeine.
5. Extraction of piperine from black pepper.
6. Phytochemical screening of *Curcuma longa* by solvent extraction: Terpenes and polyphenols

Essential Readings:

- Patrick G.I. (2017). 6th Edition. Introduction to medicinal chemistry. Oxford, UK: OxfordUniversityPress.ISBN-13: 978-0198749691.
- Silverman, R.B. and Holladay, M.W. (2015). 3rd Edition. The organic chemistry of drug design and drug action. San Diego, USA:Elsevier,AcademicPress.ISBN-13:9780123820303.
- Ashutosh Kar (2020) Advanced Practical Medicinal Chemistry 3rd Edition New Age International Private Limited, ISBN-10 : 9388818458

Suggestive Reading:

- Wermuth, C.G., Aldous, D., Raboisson, P. and Rognan, D. (2015). 4thEdition. The practice of medicinal chemistry. San Diego, USA: Elsevier, Academic Press. ISBN-13:978-0124172050.
- Nogrady, T. and Weaver, D.F. (2005). 3rd Edition. Medicinal chemistry: A molecular and biochemical approach. New York, USA: Oxford University Press. ISBN-13:978-0195104561.
- King F.D. (2003). 2nd Edition. Principles and practice of medicinal chemistry. London, UK: The Royal Society of Chemistry. ISBN-13: 978-0854046317.
- Gringauz, A. (1996). 1st Edition. Introduction to medicinal chemistry: How drugs act and why. Brooklyn, New York, USA: WileyVCH.ISBN-13:978-0471185451.

DISCIPLINE SPECIFIC CORE COURSE- 9 (BIOMED-DSC-09) BIOSTATISTICS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
BIOSTATISTICS – DSC 09	4	3	0	1	XII Passed	Basic knowledge of biology

Learning objectives

The Learning objectives of this course are as follows:

- To acknowledge, appreciate and effectively incorporate the basic statistical concepts indispensable for carrying out and understanding biological hypotheses, experimentation as well as validations.
- The course is aimed to create awareness about the applications of statistics in biological sciences along with building confidence in students to test their experimental data with an appropriate test of significance.

Learning outcomes

Having successfully completed this course, students shall be able to:

- Appreciate the importance of statistics in biological sciences. They will also understand the concept of different variables and data types, and also the sampling techniques.
- Learn different measures of central tendency and dispersion with their applications. The students will also learn symmetric and asymmetric distributions, and kurtosis of distributions.
- Identify the degree of uncertainty in making important decisions, learning joint probability, conditional probability, Bayes' theorem and solving its application-level problems.
- Learn about the characteristics of normal, binomial and Poisson probability distributions. They will learn how to identify which type of distribution fits the given data and estimate

probabilities for random variables in these distributions

- Determine the strength of the relationship between two variables and also to predict the value of one variable given a value of another variable.
- Learn how to formulate statistical hypotheses for testing and application of different tests of significance for hypothesis testing for different biological problems.

SYLLABUS OF BIOMED-DSC-09

Unit I: Introduction to Biostatistics (02 hrs)

Types of data in biology, random variables: discrete and continuous. sample and population, techniques of sampling (random and stratified), sampling and non-sampling errors.

Unit II: Descriptive Statistics (08 hrs)

Measures of central tendency: arithmetic mean, mode, median and partition values. Measures of dispersion: range, standard deviation, coefficient of variance and covariance, masures of skewness: Pearson's Coefficient of skewness, and concept of kurtosis (platykurtic, mesokurtic and leptokurtic).

Unit III: Probability (05 hrs)

Basic concepts, addition and multiplication, rules of probability, conditional probability, Bayes' theorem and its applications in biostatistics.

Unit IV: Probability distributions (06 hrs)

Binomial and normal distributions along with their properties and relationships. Introduction to poisson distribution.

Unit V: Correlation and Linear Regression (06 hrs)

Correlation analysis: scatter diagrams, Pearson's and Spearman's coefficient of correlation, coefficient of determination.

Simple linear regression analysis: method of least squares, equations of lines of regression and their applications in biostatistics.

Unit VI: Hypothesis testing (18 hrs)

Sampling distributions and standard error, Null and Alternate hypothesis, Basic concept and illustrations of type I and type II errors, concept of confidence interval estimation. Large sample tests for single mean and difference of means.

Student's t-distribution: test for single mean, difference of means and paired t-test. Chi-square distribution: test for goodness of fit, independence and homogeneity. F-test, one-way and two-way analysis of variance (ANOVA).Non-parametric analysis: The Sign test and The Wilcoxon signed-rank test.

Practical (30 hrs)

The computer-based experiments are designed for students to solve biostatistics problems. All theoretical concepts would be covered in the practical using any spreadsheet software like MS EXCEL.

1. Represent different types of data in tables and graphs (Line chart, histogram, bar chart, frequency polygon, pie chart).
2. Calculate various measures of central tendency (Arithmetic mean, mode, median and partition values) and dispersion (Range, standard deviation, coefficient of variance and covariance).
3. Calculate probabilities for different distributions- normal and binomial.
4. Prepare scatter plot between two variables and interpret the relationship between them using correlation and simple linear regression analysis.
5. Perform large sample test for single mean and difference of means.
6. Perform Student's t-test for one sample, independent samples, and paired samples.
7. Perform Chi-square test.
8. Perform One-way ANOVA.
9. Perform Two-way ANOVA.
10. Perform Non-parametric analysis: The Sign test or The Wilcoxon signed-rank test.

Essential readings:

- Daniel, W.W. and Cross, C.L. (2019). 11th Edition. Biostatistics: A foundation for analysis in the health sciences. New York, USA: John Wiley & Sons. ISBN: 9781119588825.
- Pagano, M. and Gauvrean, K. (2018). 2nd Edition. Principles of biostatistics. California, USA: Duxbury Press. ISBN-13: 9781138593145.
- Schmuller, J. (2016). Statistical Analysis with Excel for Dummies. 5th Edition. New York, USA: John Wiley & Sons. ISBN: 9781119844549.

Suggestive readings:

- Triola M.M., Triola M.F., Roy J. (2019). Biostatistics for Biological and Health Sciences. Harlow, UK: Pearson Education Ltd.
- Zar, J.H. (2014). 5th Edition. Biostatistical analysis. USA: Pearson. ISBN: 9789332536678Glantz, S. (2012). 7th Edition. Primer of biostatistics. New York, USA: McGraw-Hill Medical. ISBN: 9780071781503.

POOL OF DSE FOR 3rd SEMESTER & 4th SEMESTER

DISCIPLINE SPECIFIC ELECTIVE COURSE –1 (BIOMED-DSE-1) PROTEINS AND ENZYMES

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
PROTEINS AND ENZYMES BIOMED-DSE-01	4	3	0	1	XII Passed	Basic knowledge of Biochemistry

Learning objectives

The Learning Objectives of this course are as follows:

- The objective of this course is to provide an overview of protein biochemistry and enzymology.
- Proteins and enzymes, being the most versatile functional entities, hold several applications in life sciences research as well as in industry and biomedicine.
- The biochemical, structural, and functional aspects of the interaction of proteins and enzymes will be introduced in this course.

Learning outcomes

The Learning outcomes of this course are as follows:Having successfully completed this course, students shall be able to learn and appreciate:

- The unique features and characteristics of proteins and enzymes and their applications in research, medicine, and industry.
- The relationship between three–dimensional structure of proteins and enzymes and their functions.

- The basic mode of action of enzymes and their remarkable regulation.
- The protein misfolding and the diseases associated with it.
- The students would be able to understand the various biomedical applications of enzymes.
- The students would be able to gain hands-on experience in working with proteins and enzymes from various sources. Hence, it will improve their learning skills and imbibe the basic concepts of this field.

SYLLABUS OF BIOMED-DSE 01

Unit I: Structural organization of proteins (08 hrs)

Organization of protein structure- primary, secondary, tertiary, and quaternary. Secondary structures – helices, sheets and turns. Motifs, domains and their functional importance. Native and denatured state of a protein. Physico-chemical interactions that maintain the native structure of a protein.

Unit II: Protein folding and diseases related to protein misfolding (10 hrs)

Protein folding (Hydrophobic collapse), Anfinsen theory, Levinthal paradox and protein folding in the cytoplasm. Protein denaturation by chaotropic agents such as urea, GnHCl. Concept of how mutation causes protein misfolding (loss-of-function to toxic-gain-of function) and related diseases such as Alzheimer's disease, Prion diseases, Tay-Sachs disease and Huntington disease.

Unit III: Enzymes: characteristics and kinetics (14 hrs)

Classification of enzymes and nomenclature. Concept of multi-functional enzyme and multi-enzyme complex. Fischer's lock & key and Koshland's induced fit hypotheses. Enzyme specificity. Enzyme kinetics- Michaelis-Menten equation, Lineweaver-Burk plot. To understand the physiological significance of K_m, V_{max}, K_{cat} and the factors affecting enzyme activity. Basics of enzyme inhibition- reversible (competitive, uncompetitive, non-competitive) and irreversible inhibition.

Unit IV: Regulation of enzyme activity (06 hrs)

Allosteric regulation, feedback inhibition, reversible covalent modification (Phosphorylation, glycosylation and acetylation using example of glycogen phosphorylase/glycogen synthase). proteolytic activation- zymogens.

Unit V: Biomedical application of enzymes **(07 hrs)**

Applications of enzymes in the diagnosis of diseases using creatine kinase and glucose oxidase and in therapy (streptokinase). Enzyme inhibitors as drugs. Principle of enzyme immunoassay. Enzyme immobilization and its applications, concept of abzymes. Industrial applications of enzymes (biosensor - HRP; food industry- rennin; cosmetics-collagen, etc)

Practical **(30 hrs)**

(Wherever wet-lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs, etc.)

1. Enzyme-based diagnostic assay (any one).
2. Measurement of enzyme activity and calculation of specific activity of an enzyme.
3. Effect of pH on enzyme activity.
4. Effect of temperature on enzyme activity
5. Visualization of 3D protein structure using suitable software.
6. Analysis of type of enzyme inhibition from the given experimental data
7. To study the effect of protein denaturants such as acid, alkali, heat and any organic solvent on protein.
8. Study of images of various toxic protein oligomeric species, associated with human diseases (amyloids, disordered aggregates, amorphous aggregates).

Essential readings:

- Nelson, D. L., & Cox, M. M. (2021). *Lehninger: Principles of Biochemistry* (8^{th} ed.). Macmillan. ISBN: 9781319322328.
- Berg, J., Gatto, G., Stryer, L. and Tymoczko, J. L. (2019). *Biochemistry*. New York, USA: W. H. Freeman and Company.
- Voet, D., Voet J., Pratt, C. (2018). *Principles of Biochemistry*(5^{th}ed.) Wiley Blackwell. ISBN: 978-1-119451662.
- Plummer, D. (2017) An Introduction to Practical Biochemistry, (3^{rd} ed.). McGraw-Hill College; ISBN-13: 978-0070841659.

Suggestive readings:

- Devlin, (2011). Textbook of Biochemistry with Clinical Correlations. UK: Wiley T & Sons.
- Campbell, M. K. and Farrel, S. O. (2012) (7thed.). Biochemistry. Boston, USA: Brooks/Cole Cengage Learning. ISBN: 13:978-1-111-42564-7
- Cooper, T.G. (2011). The Tools of Biochemistry (2nded.). Wiley-Inter science Publication (New Delhi). ISBN: 13:9788126530168.
- Sheehan, D. (2009). Physical Biochemistry (2nded.). Wiley-Blackwell (West Sussex), ISBN: 9780470856024/ISBN: 9780470856031.
- Nicholes,C.P., Lewis, S. (1999). Fundamentals of Enzymology (3rd ed.). Oxford University Press Inc. (New York), ISBN:0 19850229 X

DISCIPLINE SPECIFIC ELECTIVE COURSE –02 (BIOMED-DSE-02) PRACTICES IN BIOSAFETY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
PRACTICES IN BIOSAFETY BIOMED-DSE-02	**4**	**3**	**0**	**1**	**XII Passed**	**Basic knowledge of biology**

Learning objectives

- Recent advances in the field of Biomedical Research have brought into focus the need for certain practices and strategies to prevent exposure to pathogens and toxins.
- The inventions in the field of Genetic Engineering have significantly influenced agriculture, medicine and food processing industry. Thus implementation of biosafety enables number of procedures and rules that will be helpful in protecting humans and environment from disease causing microorganisms, pests, additives, contaminants and residues etc.
- Topics such as responsible use of biotechnology, biosafety levels, genetically modified (GM) food, biosafety regulations, impact of biotech processes on environment are of major significance in present scenario.

Learning outcomes

- In this students would understand application of biotechnology in different fields like agriculture, environment, industrial manufacturing, food processes, health and medicine etc. It will enable them to recognize implication of recombinant biomolecules and organisms on our society.

- This would enable students to know about various hazardous biological substances one can come across while working in the laboratory or day today life, and the steps taken to minimize the risk. The students would understand different regulations for handling biohazard and radioactive material.
- The course should kindle the inquisitiveness in students about genetically modified and living modified organisms (GMO & LMO) and their impact on the environment.

SYLLABUS OF BIOMED-DSE-02

Unit I: Introduction to biosafety (04 hrs)

Historical background of Biosafety, definition of biosafety, application of biosafety and need for biosafety.

Unit II: Social responsibility of biotechnology and biomedical research (08 hrs)

Legal and socio-economic impacts of biotechnology. Social responsibility towards safety measures.Social and ethical implications of biological weapons (Bioterrorism).Implication of recombinant biomolecules and organisms. Implication of gain of function research. Importance of biotechnology: benefits and limitations of transgenic to human health, society and the environment.

Unit III: Biosafety and importance of containment facility (08 hrs)

Components of biosafety (biohazard and biosecurity), measures of biosafety, containment (good laboratory practices and techniques, safety equipment, design facility), types of containment (physical and biological). Biosafety levels (BSL 1, 2, 3, 4), barriers (physical and secondary).

Unit-IV: Genetically modified organism: concerns and challenges (10 hrs)

Government of India definition of genetically modified organisms (GMOs) and living modified organisms (LMOs), roles of institutional biosafety committee, review committee on genetic manipulation (RCGM), genetic engineering approval committee (GEAC) for GMO applications in food and agriculture, environmental release of GMO in rDNA biosafety guidelines of India. Biosafety assessment procedures for biotech foods and related products, including transgenic food crops, case studies of relevance. Biosafety assessment of pharmaceutical products such as drugs/vaccines etc.

Unit-V: Handling and transportation of GM, infectious and radioactive materials (09 hrs)

Classification of infectious organisms, transportation of genetically modified/infectious organisms, General preparation of shipments for transport: Basic triple packaging system, marking of packages, labelling, precautions, monitoring strategies and methods for detecting transgenic; radiation safety and non-radio -isotopic procedures.

Unit VI: Biosafety guidelines and regulations (06 hrs)

Aim of biosafety guidelines, biosafety and risk assessment issues; regulatory framework; national biosafety policies and law, the cartagena protocol on biosafety, WTO and other international agreements related to biosafety.

Practical (30 hrs)

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs)

1. Protocol for development of recombinant / engineered proteins as therapeutics
2. Preparation of comparative account on BSL 1, 2,3,4. (poster, oral presentation, video)
3. Categorization of list of provided hazardous materials and its handling & disposal
4. To study GEAC guidelines on genetically modified crops (Bt-cotton/Bt-brinjal)
5. To develop an understanding of the role and composition of an ethical committee for research by a presentation mode.
6. To study and develop a flowchart to demonstrate spread and containment of any two infectious diseases (typhoid, SARS, Ebola, Dengue, Tuberculosis and Covid).
7. Preparation of chart explaining significance of various symbols used in chemistry and biology laboratories/ reagent bottles and equipment.

Essential Readings:

- Hunt, E. F. and Colander, D. C. (2019). 17th edition. Social science: An introduction to the study of society. Boston, USA: Pearson/Allyn and Bacon. ISBN 9781138592537.
- Helga, K. and Peter, S. (2016). 3rd edition. A companion to bioethics. New Jersey, USA: John Wiley and Sons. ISBN 9781118941508.
- Beauchamp, T.L and Childress, J.F. (2013). 8th edition. Principles of biomedical ethics.

Oxford, UK: Oxford University Press. ISBN 9780190640873.

- Peter, A. S. and Viens, A. M. (2008). 1st edition. The Cambridge textbook of bioethics. Cambridge, UK: Cambridge University Press.ISBN 9780521872843.
- Sateesh, M.K. (2008). 1st edition. Bioethics and Biosafety. New Delhi, India: I K International Pvt Ltd. ISBN 978-8190675703.

Suggestive readings:

- Rebecca, G.; James, F. H.; Karim, M. M.; Cholani,W. (2011). 1st edition. Environmental safety of genetically engineered crops. Michigan, USA: Michigan State University Press. ISBN 978-1611860085.
- Sreekrishna, V. (2007). 1st edition. Bioethics and biosafety in biotechnology. New Delhi, India: New Age International (P) Ltd. ISBN 978-8122420852.
- Rajmohan, J. (2006). 1st edition. Biosafety and bioethics. New Delhi, India: Isha Books. ISBN 13: 9788182053779.
- Tomme, Y. (2004). 1st edition. Genetically modified organisms and biosafety. Gland, Switzerland: World Conservation Union publications. ISBN 2831707986

DISCIPLINE SPECIFIC ELECTIVE COURSE –03 (BIOMED-DSE-03) SOCIAL AND PREVENTIVE MEDICINE

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
SOCIAL AND PREVENTIVE MEDICINE **BIOMED-DSE-03**	**4**	**3**	**0**	**1**	**XII Passed**	Student should have studied science (Biological science/ Physical sciences)

Learning objectives

- The origin of medicine to alleviate human suffering from disease, and control of disease is as old as origin of human itself. Various civilizations practiced their own methods to treat and control diseases.
- The modern form of medicine that has evolved over time, is composed of two main branches viz: Curative medicine and Preventive medicine/Public health. It has been realized that causes of diseases are multifactorial- a disease can have multiple causes/factors such as social, economic, genetic, psychological and environmental factors.
- In the centre of modern medicine is epidemiology, which is concerned with measuring distribution patterns and determinants of disease in a Population/community, and needs of health related services.
- The health related services are delivered through health programmes and health systems to various risk groups such as at risk-mothers, at risk-infants, elderly or chronically ill patients.

Learning outcomes

- Introduction to various concepts of health and disease, factors determining health of individuals or population/community, interaction of factors in causing disease. Students will also be introduced to the concepts of levels of prevention adopted to achieve a state of health or to preserve health.
- Epidemiology is in the core of basic science of social preventive and medicine, and is concerned with study/measurement of the distribution and determinants of health related issues. Students will be introduced to the concepts of epidemiology, various methods and approaches that are used to measure the intensity and distribution of health related issues in the community/population.
- Introduction to the various definitions/ concepts related to natural history of disease viz: mode of disease transmission and progress of infection/disease in the host. Students would get opportunity to learn natural history of communicable disease, diagnosis, treatment and control, and various health programmes for prevention (with examples of certain prevalent diseases in India. Through examples of few diseases prevalent in India and globally, epidemiology of those diseases which are considered as lifestyle diseases or multi-factorial diseases will be introduced.
- The definition of health also includes dimensions of social and mental well-being. Therefore, mental illness has been recognized as one of the important health issues. Students will be introduced to the various types of mental illness and its prevention.
- Infertility is a worldwide problem, and estimates of infertility in India are about 4-6 percent. Childlessness is social and demographic implications. The etiology of infertility is variable. Mother and children are considered as special-risk group in a population, and is a priority group in any community. The mother, and the growth and development of fetus/ infants are at the risk of several health problems. Further, under certain circumstances, their survival too is at risk. The multitude of problems affecting the health of mother and child constitutes serious health problems in a developing country. Students will be introduced to the various maternal and child health related problems/ complications (and their prevention), from conception to the birth of infants.
- Health has been declared a fundamental human right and has to be delivered by the governments to all. Therefore, there is a system to promote and provide health services to every individual living in urban or rural settings. Students will be introduced briefly about the system of health care and various levels of health care in India.

SYLLABUS OF BIOMED-DSE-03

Unit I: Basic concepts of health and disease **(06 hrs)**

Definition, determinants and indicators of health and disease, demography (transition, and sources of demographic data, registries), survey methodology including census procedures and sampling. epidemiological triad. Multi-factorial aetiology of disease. Concepts of prevention and control.

Unit II: Epidemiology and epidemiological methods **(06 hrs)**

Definition and history, components of epidemiological studies viz. disease frequency, distribution and determinants. Basic measurements/tools in epidemiology: rates, ratios and proportions (mortality and morbidity rates and ratios, prevalence, incidence); epidemiological studies: descriptive, analytical, randomized controlled trials. Concept of association and causation. Brief introduction to modern epidemiological tools.

Unit III: Epidemiology of diseases **(16 hrs)**

Various definitions: epidemic, endemic, pandemic, sporadic, nosocomial infections etc. Cases, carriers, transmission of disease, concept of incubation period, generation time, communicable period and secondary attack rate.

a. Communicable diseases: control and health care programs for of national importance (extent of problem in India and worldwide, main clinical features, diagnosis, treatment & resistance, immunization and prevention practices, health programmes (if applicable):

Respiratory infections:	*Tuberculosis*
Intestinal infections:	*Cholera*
Arthropod-borne infections:	*Malaria*
Zoonosis:	*Rabies*
Sexually transmitted infection:	*AIDS*

b. Non-communicable disease: control and health care programs for of national importance (extent of problem, diagnosis, treatment and control, health programmes (if applicable): Hypertension, stroke, diabetes, breast cancer.

Unit IV: Mental health **(05 hrs)**

Introduction and scope. Features of mentally healthy person, signs of poor mental health, types of mental health (anxiety and depression), and prevention. National Mental Health Programme

(NMHP).

Unit V: Infertility, mother and child health (06 hrs)

Measures of fertility and factors affecting fertility, child health, maternal health, immunization programme.

Unit VI: Health care system in India (06 hrs)

Concept of health care, levels of health care, brief introduction to Primary Health Care in India (village level, sub-centre level, primary health centre level, community health centre level, hospitals).National Programme for Health Care of the Elderly (NPHCE).

Practical (30 hrs)

(Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. To explore any publically available database for tuberculosis/typhoid and study its epidemiology in the Indian population.
2. To study the epidemiology of malaria including geographical and seasonal distributions in India through a public database.
3. To study various parameters like risk factors, incidence, prevalence, mortality rate and DALYs. for any specific type of cancer prevalent in India through NCRP or any other public database.
4. To study the burden and causes of any hematological disorder in the Indian population.
5. To explore and analyse various national and international disease databases like ICMR/WHO/CDC/ etc.
6. To prepare a questionnaire for any health condition studied in S.No. 1-5.

7-10. To prepare a poster/ presentation using any digital media to communicate about the epidemiology and to create awareness about any health condition studied in S.No. 1-5.

Essential reading

- Park, K. (2021), 26th Edition, *Park's Textbook of Preventive and Social Medicine*,

Banarsidas Bhanot Publisher, ISBN-13 : 978-9382219163.

Suggestive reading:

- Bonita, Ruth, Beaglehole, Robert, Kjellström, Tord& World Health Organization. (2006) 2nd edition. *Basic Epidemiology*, World Health Organization, ISBN 978 92 4 154707 9.

GENERIC ELECTIVE COURSE -04 (BIOMED-GE-04): BIOCHEMICAL BASIS OF LIFE

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
BIOCHEMICAL BASIS OF LIFE BIOMED-GE-04	4	3	0	1	XII Passed	Basic knowledge of biology

Learning objectives

The Learning Objectives of this course are as follows:

- The objective of this course is to address how the wonderful and remarkable properties of living organisms arise from the various biomolecules, the building blocks.
- The course focuses on the chemical complexity and organization of molecules in a living cell, extraction and transformation of energy
- It gives insights into the changes that occurred during the gradual evolution of life.

Learning outcomes

The Learning Outcomes of this course are as follows:

- The fundamental Chemistry of Life: students will gain an understanding of the elements found in living systems and appreciate the importance of water as the solvent for living systems. It is important to learn about the units used for expressing the biochemical basis of a living system. Students will learn the unit system for the molecular mass of biomolecules, units used for the concentration of solutions, and units for expressing the distances, etc.
- Cellular foundations of life**: a** stepwise organization of a living system, starting from the smallest unit to an entire living organism would be the focal point in this unit.

- Molecular basis of life**: s**tudents will understand the monomeric forms of different types of biomolecules. In addition, the relationship between the structure and function of biomolecules would also be learnt.
- Physical foundation of life: students would learn the concept of enthalpy, entropy and free energy in a living system and understand the importance of the energy currency and the significance of coupled biochemical reactions.
- Biochemical events in the origin of life: students would learn the origin of life and the nature of transformative changes that occurred for life to evolve from the pre-biotic world to the modern times.

SYLLABUS OF BIOMED-GE-04

Unit I: The fundamentals of chemistry of life (06 hrs)

Carbon chemistry of life, structure and importance of water, diverse inorganic ions, major elements (C, H, O, N, S), trace elements. Units used in biochemistry such as those expressed for the atomic mass unit (daltons), concentration (moles/litre) and distance (in nanometer-scale).

Unit II: Cellular foundations of life (06 hrs)

Levels of organization in a living system. The important features of living cells, subcellular organelles in eukaryotic cells and subcellular organization in prokaryotic cells. Brief description on phototrophs, chemotrophs, autotrophs and heterotrophs.

Unit III: Molecular basis of life (12 hrs)

Common functional groups and linkages in biomolecules.

Macromolecules: classification, building blocks, structural and functional diversity. Structural and functional forms of macromolecules: Proteins (collagen, albumin, hormones (insulin), enzyme (proteases, nucleases, amylases and lipases); Polysaccharides (starch, glycogen, cellulose), Nucleic acids, Lipids (cholesterol and triglycerides).

Unit IV: Physical foundation of life (11 hrs)

Enthalpy, Entropy, Free Energy, Standard Free Energy, Equilibrium constant, Open and closed systems, endergonic and exergonic reactions, the energy currency in a biological system (ATP), energy coupling reactions.

Unit V: Biochemical events in the origin of life **(10 hrs)**

Landmark events in the evolution of life. Biochemical basis of the origin of aerobic and anaerobic world. Evolution of biological monomers and polymers from pre-biotic compounds. Properties of DNA as genetic material. Structural and functional analysis of eukaryotes and prokaryotes, with suitable examples.

Practical **(30 hrs)**

(Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Preparation of buffer at a specific molarity and pH.
2. Numerical problems based on Enthalpy, Free Energy and Entropy.
3. Comparative analysis of protein content in egg white and egg yolk using Bradford method.
4. Detection of a glucose polymer (starch) in rice/potato/corn, using iodine test.
5. To assess the differential solubility of lipids in aqueous and organic solvents.
6. Extraction of DNA from plant/microbial cells by the spooling method.
7. Demonstration of agarose gel electrophoresis for analyzing the isolated DNA.
8. To compare the structural features of a prokaryotic and eukaryotic cell by studying their electron micrographs.

Essential readings

- Nelson, D.L. and Cox, M.M. (2021). Lehninger: Principles of Biochemistry(7^{th} ed.). W.H. Freeman & Company (New York), ISBN:13:9781319322328
- Pratt, C.W. and Cornely, K.(2017). Essential Biochemistry (4^{th} ed.) John Wiley& Sons, Inc.ISBN:9781119012375
- Plummer, D.T. (2012). An Introduction to Practical Biochemistry. New Delhi, India: McGraw-Hill College.

Suggestive readings:

- Berg, J., Gatto, G., Stryer, L. and Tymoczko, J. L. (2019). Biochemistry. New York, USA: W. H. Freeman and Company.
- Campbell, M. K. and Farrell, S. O. (2017) 9th Edition. Biochemistry. Boston, USA: Brooks/Cole Cengage Learning. ISBN-13: 978-1305961135

GENERIC ELECTIVE-05 (BIOMED-GE-05) HEALTH AND BODY DEFENSE SYSTEM

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
HEALTH AND BODY DEFENSE SYSTEM BIOMED-GE-05	4	3	0	1	XII Passed	Basic knowledge of biology

Learning objectives

The Learning Objectives of this course are as follows:

- Characteristics of a healthy body and ways to improve one's health and well-being.
- Body defense system is a comprehensive study of the organization and functioning of the immune system with its network of cells and molecules. Understanding the biology of the immune system is key to developing strategies towards prevention and cure to a number of disorders and diseases that result due to malfunctioning and dysregulation of the immune system.
- This paper covers the organization and functioning of the various branches of immune system, namely, Innate and adaptive Immunity to combat different pathogens. Various Immunological techniques will also be taught to the students.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Students learn various aspects of health and immune system in normal and infectious stage which equips students to design better strategies for combating the immunological disorders. Students will be given an overview to various pathogens and immune system in Invertebrates and Vertebrates.

- Students learn historical perspective of the extensive field of Immunology. They are introduced to the important concepts of Immunology.
- Students will be familiarized with origin and maturation of all blood cell types in bone marrow and thymus. They will understand the process of haematopoiesis, functions of various types of cells and roles played by them in generating immune responses against pathogens.
- The unit entails different barriers of Innate Immunity, Cells, Complement system, Patterns on the pathogens recognized by receptors of Innate Immune system, pathogen killing by the immune cells and concept & the importance of the Inflammation in an Immune response.
- Students will learn about the cells of adaptive immune system, the concept of antigen, antibody molecules and role of major histocompatibility complex & associated cells in the processing and presentation of antigen. The students will explore the branches of adaptive immunity - the humoral and cell mediated, their components and interplay of these components in combating the infection. The students will also be able to understand the significance of various kinds of growth factors and cytokines in the activations of various lymphocytes
- The students will be given knowledge about the principle, methodology and applications of various laboratory techniques involving antigen-antibody reaction.
- Vaccine based immunotherapies and their designing will assist them to think about new path for combating with pathogens and working mechanisms of immune system.
- The students will be made aware about the importance of diet and lifestyle in promoting Immunity and health.

SYLLABUS OF BIOMED-GE-05

Unit I: Hallmarks of health (06 hrs)

Basic aspects of healthy body: cells, tissue and organ system, difference between prokaryotes and eukaryotes. Key differences between bacteria, fungi, protozoans and viruses.
Requirements for ahealthy body according to age and gender. Survival strategies of host against the invading pathogens: bacterial defense against bacteriophage, immune system of plants, invertebrates (mollusca) and vertebrates.

Unit II: Introduction and Organization of Immune System (06 hrs)

Historical background, general concepts of the immune system, innate and adaptive immunity; active and passive immunity, contributions of Sir Edward Jenner and Louis Pasteur in vaccine development. Lymphoid organs: thymus, bone marrow and haematopoiesis, lymph nodes, spleen

Unit III: Innate Immune response (09 hrs)

Physical and chemical barriers; cells of the innate immune system: natural killer cells, monocytes and macrophages; neutrophils, eosinophils, basophils, mast cells and dendritic cells: structure, phenotypic and functional aspects.

Complement system: components of the complement activation classical, alternative and lectin pathways; biological consequence of complement activation.

Mechanisms of pathogen killing by macrophages and neutrophils: receptor/non receptor mediated endocytosis, phagosome formation, phagolysosome formation, respiratory burst phenomenon.

Inflammation: concept, hall marks of inflammation.

Unit IV: Adaptive Immune Response (10 hrs)

Cells of the adaptive immune system: T and B lymphocytes; characteristics of adaptive immune response: self and non-self recognition, specificity, diversity and memory, primary and secondary immune response, allergen/ allergy.

Antigens: antigenicity and immunogenicity, haptens. Properties (foreignness, molecular size, heterogeneity, route and dose of administration, solubility and degradability); host factors (genotypes, gender, nutrition);blood group antigens and transfusion reactions.

Basic function of major histocompatibility complex

Importance of Antigen presentation; types of antibodies and their function; cell mediated immune response. Major steps in T cell differentiation in thymus: thymic selection, self MHC restriction, T cell receptor assembly. Phenotypic characteristics of naïve T-cells ($CD4^+$ and $CD8^+$ T-cells). Migration of naïve T-cells from thymus to secondary lymphoid organs. Activation of T-cells, proliferation of clonally selected T cells and their effector functions, concepts of T-helper 1 (TH_1) and T-helper 2 (TH_2) cells. Basic introduction to cytokines: IL-2, IL-4 and IFN-γ. Contribution of MHC, B-cell receptor (BCR) and T-cell receptor (TCR) to diversity in adaptive immune response

Unit V: Immunological principles of various reactions and techniques (05 hrs)

Basic concepts of antigen-antibody interactions (epitope-paratope), affinity and avidity, cross reactivity, precipitation, agglutination, immunodiffusion, immune-electrophoresis, ELISA (indirect, sandwich, competitive, chemiluminescence, and ELISPOT assay), western blotting, immunofluorescence microscopy, immunohistochemistry and lateral flow assay.

Unit VI: Diet, nutrition and life style in promoting health and Immunity (09 hrs)

Importance of a well- balanced nutrition, the role of Immunity boosters and immunomodulators from kitchen shelf (Any two: turmeric, ashwagandha, tomato & giloy), vitamins and minerals in improving health and defense. Role of probiotics, gut microbiota and prebioticsin regulating health and immunity. Role of physical activity and emotional & Mental state in regulation of immunity status, holistic health and happiness. A primer on our traditional practices, yogic lifestyle and meditation in creating homeostasis in the body (balancing *Vatta, Pitta* and *Kapha*) will also be given.

Practical (30 hrs)

(Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Visualization of antigen-antibody interaction by Ouchterlony method
2. To perform Immuno-diffusion by Mancini Method
3. To perform Complement fixation assay
4. To perform sandwich dot ELISA
5. To perform Widal test (Indirect/passive agglutination) for the detection of typhoid antigen and blood group determination (direct agglutination)
6. To perform SARS-CoV-2 rapid antigen test(Lateral flow Assay)
7. Project work based on historical research work in the area of immunology.
8. Case studies on hypersensitivity reactions(seafood hypersensitivity, erythroblastosis fetalis)

Essential readings:

- Punt, J. Stranford, S. Jones, P. and Owen, J. (2019). 8th Edition. Kuby Immunology. New York, USA: W.H. Freeman and Company. ISBN- 13: 978-1464189784.
- Delves, P.J. Martin, S.J. Burton, D.R. and Roitt, I. M. (2017). 13th Edition. Roitt’s Essential Immunology. New Jersey, USA: Wiley-Blackwell Science. ISBN: 13: 978- 1118415771.

Suggestive readings for basics:

- Ananthanarayan R and Jayaram Paniker CK (Author), Reba Kanungo (Editor) (2020) Ananthanarayan and Paniker's Textbook of Microbiology, Eleventh Edition. Universities Press (India) Pvt. ISBN **9389211433**
- Willey, J. Sherwood, L and Woolverton, C.J. (2016). 10th Edition. *Prescott's Microbiology*. New York, USA: McGraw-Hill Education. ISBN-13:978-1259281594.
- Satomi Oshima; Zhen-Bo Cao; Koichiro Oka (2015) 'Physical Activity, Exercise, Sedentary, Behavior and Health' Springer Tokyo Heidelberg New York Dordrecht London ISBN 978-4-431-55333-5 (eBook)
- Guglielmo M Trovato (2012) Behavior, nutrition and lifestyle in a comprehensive health and disease paradigm: skills and knowledge for a predictive, preventive and personalized medicine. Trovato EPMA Journal 2012, 3:8 (Review Article)
- Kindt T. J., Osborne B. A., Goldsby R. A. (2007). 6th Edition *Kuby Immunology*. New York, USA: W.H. Freeman and Company. ISBN-13: 978-1429202114 ISBN-10: 1429202114.
- Hay, F.C. and Westwood, O.M.R. (2002). 4th Edition. *Practical Immunology*. New Jersey, USA: Blackwell Science. ISBN:9780865429611
- Practical Ayurveda: Find Out Who You Are and What You Need to Bring Balance to Your Life Paperback – 5 June 2018 by Sivananda Yoga Vedanta Centre. Publisher : DK; Illustrated edition (5 June 2018) ISBN-10 : 1465468498, ISBN-13 : 978-1465468499.
- BYG-002 Yoga and Health, Block 4 Yogic Lifestyle, School of Health Science, Indira Gandhi National Open University (https://drive.google.com/file/d/10j00rWXLsCEV5cTbzK-hM43ezlNvn0hl/view)

GENERIC ELECTIVE -06 (BIOMED-GE-06) UNDERSTANDING THE HUMAN BODY SYSTEMS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
UNDERSTANDING THE HUMAN BODY SYSTEM BIOMED-GE-06	4	3	0	1	XII Passed	Basic knowledge of human physiology

Learning objectives

The Learning Objectives of this course are as follows:

- This is an introductory course dealing with the structure and function of the human organism and the issues facing the human in today's world.
- It is intended for students with limited science background. It would make them familiar with basic physiological concepts.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Students will have an increased understanding and appreciation for the workings of the human body. They will be familiar with the terminology and physiology of the major organ systems
- They will be able to explain the relation between form and function in biology, as expressed in molecular, cellular, and whole-organism physiology.
- Students will be able to recognize the anatomical structures and explain the physiological functions of the body systems.
- Recognize the anatomical structures and explain the physiological functions of the body systems. Develop scientific terminology to describe the parts and processes of the human body.

SYLLABUS OF BIOMED-GE- 06

Unit I: Body organization and integumentary system (05 hrs)

General anatomy of the body, introduction to various kinds of body planes, cavities and their membranes, tissues level of organization and classification (types, origin, function & repair). Structure and functions of human skin. Blood as connective tissue

Unit II: Nervous and Endocrine system (10 hrs)

Organization of the central and peripheral nervous system. Nerve physiology, motor and sensory physiology(special senses). General mechanism of hormone action, structure, function and regulation of the major gland of the body: pituitary, hypothalamus, thyroid, pancreas and adrenals. Basic concepts about hypo and hyper secretion of hormones.

Unit III: Muscular and skeletal system (05 hrs)

Functional anatomy of muscular system, types of muscles, neuromuscular junction structure, property and transmission, general characteristics of muscle contraction using skeletal muscle as example.

Unit IV: Cardiovascular and respiratory system (08 hrs)

Functional anatomy of heart, the cardiac cycle, electrocardiogram. Circulatory system: Blood vessels, hemodynamics and regulatory mechanisms. Lymphatic circulation - hemodynamics and regulation, micro-circulation, functional anatomy of the respiratory system. Mechanisms of pulmonary and alveolar, gaseous exchange, transport of gases, respiratory and nervous control and regulation of respiration.

Unit V: Gastrointestinal system and Renal physiology (11 hrs)

Anatomy and histology of the digestive tract. General principles of gut motility secretion, digestion, absorption and assimilation. Functional anatomy of kidney, histology of nephron and its physiology, process of urine formation. Urinary bladder: structure, micturition and its regulation

Unit VI: Reproductive System (06 hrs)

Structure and function of male and female reproductive organs. Basic concepts of gametogenesis (oogenesis and spermatogenesis), fertilization, implantation, menopause and contraception.

Practical (30 hrs)

(Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. To prepare a blood smear and identify different types of white blood cells.
2. Estimation of hemoglobin (Sahli's method)
3. Physiological data acquisition based experiments (ECG/PFT/EMG).
4. Blood Pressure recordings in humans.
5. To study a simple reflex arc
6. To study the sensation of taste, touch and smell.
7. To study various types of contraceptives (condoms, IUDs, oral and injectable contraceptives)
8. To study different human organs and their sections through permanent histological slides T.S. of brain, spinal cord, skeletal fibers, cardiac muscles, skeletal muscles, T. S. of thyroid, liver, thymus, spleen, ovary, artery, vein, capillaries, testis, pancreas, esophagus, adrenal, kidney (cortex and medulla), urinary bladder, fallopian tubes, epididymis, lungs, trachea, heart. (minimum 8 slides covering the systems mentioned in theory).

Essential readings:

- Guyton and Hall Textbook of Medical Physiology, 14th edition (2020), J. E. Hall; W B Saunders and Company, ebook ISBN: 978-0-3236-4003-9; Hardcover ISBN: 978-0-3235-9712-8
- Principles of Anatomy and Physiology, 16th edition (2020), Gerard J. Tortora and Bryan H. Derrickson; Wiley and Sons, ISBN: 978-1-119-66268-6. (e book), ISBN: 978-1-119-70438-6 (for print book).
- Textbook of Practical Physiology, 9th edition (2019), CL Ghai; Jaypee Publication, ISBN-9789352705320.
- Human Physiology, 16th edition (2011), Stuart I. Fox; Tata McGraw Hill, ISBN10: 1260720462; ISBN13: 978-1-26-072046-4.

Suggestive readings:

- Ganong's Review of Medical physiology, 26th edition (2019), K. E. Barett, S. M. Barman, S. Boitano and H. Brooks; Tata McGraw Hill, ISBN 978-1-26-012240-4 (for ebook) ISBN:978-1-26-012241-1 (for print Book)

Reproductive Biology of Angiosperms
(BHCC11)
Core Course - (CC) Credit:6

Course Objective(2-3)

To have knowledge of the flowering and fruiting, reproduction process, role of pollinators, ovule and seed development.

Course Learning Outcomes

Student would have an understanding of

1. Induction of flowering and molecular and genetic aspects of flower development.
2. Pollen development, dispersal and pollination
3. Ovule development and fertilization,
4. Endosperm development and its importance
5. alternation pathways of reproduction
6. Student would be able to apply this knowledge for conservation of pollinators and fruit development

Unit 1

Introduction (2 lectures)
History (contributions of G.B. Amici, W. Hofmeister, E. Strasburger, S.G. Nawaschin, P. Maheshwari, B.M. Johri, W.A. Jensen, J. Heslop-Harrison) and scope of Reproductive Biology.

Unit 2

Anther (4 lectures)
Anther wall: Structure and functions, microsporogenesis, callose deposition and its significance.

Unit 3

Pollen biology (8 lectures)
Micro-gametogenesis; Pollen wall structure, MGU (male germ unit) structure, NPC system (no details but table to be included); Palynology and scope (a brief account); Pollen wall proteins;

Pollen viability, storage and germination; Unique features: Pseudomonads, polyads, massulae, pollinia.

Unit 4

Ovule (8 lectures)
Structure; Types; Special structures–endothelium, obturator, aril, caruncle and hypostase; Female gametophyte– megasporogenesis (monosporic, bisporic and tetrasporic) and megagametogenesis (details of *Polygonum* type); Organization and ultrastructure of mature embryo sac; Female germ Unit

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Unit 5

Pollination and fertilization (6 lectures)
Pollination types and significance; adaptations; structure of stigma and style; path of pollen tube in pistil; structure of pollen tube; double fertilization.

Unit 6

Self incompatibility (8 lectures)
Basic concepts (interspecific, intraspecific, homomorphic, heteromorphic, GSI and SSI); Methods to overcome self- incompatibility: mixed pollination, bud pollination, stub pollination; Intraovarian and in vitro pollination; Modification of stigma surface, parasexual hybridization; Cybrids(in brief with examples) , in vitro fertilization.

Unit 7

Endosperm (4 lectures)
Types (2 examples each), development, structure and functions.

Unit 8

Embryo (6 lectures)
Six types of Embryogeny (no details) ; General pattern of development of dicot and monocot embryo; Suspensor: structure and functions; Embryo-endosperm relationship; Nutrition of embryo; Unusual features; Embryo development in *Paeonia*.

Unit 9

Seed (4 lectures)
Structure, importance and dispersal mechanisms(Adaptations – Autochory, Anemochory, Hydrochory, Zoochory with 2 examples each).

Units 10

Polyembryony and apomixes (6 lectures)
Introduction; Classification (given by Bhojwani and Bhatnagar); Causes and applications.

Unit 11

Germline transformation (4 lectures)
Pollen grain and ovules through pollen tube pathway method

Practical

1. Anther: Wall and its ontogeny; Tapetum (amoeboid and glandular); MMC, spore tetrads, uninucleate, bicelled and dehisced anther stages through slides/micrographs, male germ unit (MGU) through photographs and schematic representation.
2. Pollen grains: Fresh pollen showing ornamentation and aperture, psuedomonads, polyads, pollinia (slides/photographs,fresh material), ultrastructure of pollen wall(micrograph); Pollen viability: Tetrazolium test.germination: Calculation of percentage germination in different media using hanging drop method.
3. Ovule: Types-anatropous, orthotropous, amphitropous/campylotropous, circinotropous, unitegmic, bitegmic; Tenuinucellate and crassinucellate; Special structures: Endothelium, obturator, hypostase, caruncle and aril (permanent slides/specimens/photographs).
4. Female gametophyte through permanent slides/ photographs: Types, ultrastructure of mature egg apparatus.
5. Intra-ovarian pollination; Test tube pollination through photographs.
6. Endosperm: Dissections of developing seeds for endosperm with free-nuclear haustoria.
7. Embryogenesis: Study of development of dicot embryo through permanent slides; dissection of developing seeds for embryos at various developmental stages; Study of suspensor through electron micrographs.
8.Seed dispersal mechanisms (adaptations through photographs / specimens)
9.Flourescent Microscopes can be purchased for the colleges.
(a) Study of pollen cytology to see 2-celled and 3-celled pollen grains.
(b) To perform pollen culture.
(c) To isolate protoplast from pollen grains.
(d) To study pollen-pistil interactions (fluorescent microscopes).

References

1. Bhojwani, S.S., Bhatnagar, S.P. (2011). *The Embryology of Angiosperms*, 5th edition. New Delhi, Delhi: Vikas Publishing House.
2. Johri, B.M. (1984). *Embryology of Angiosperms.* Netherlands: Springer-Verlag.
3. Raghavan, V. (2000). *Developmental Biology of Flowering plants.* Netherlands: Springer

4. Shivanna, K.R. (2003). *Pollen Biology and Biotechnology*. New Delhi, Delhi: Oxford and IBH Publishing Co. Pvt. Ltd.

Teaching Learning Process

Theory: The theory topics are covered in lectures with the help of PowerPoint presentations and the chalkboard. Students are encouraged to ask questions. The reading list has been suitably upgraded.
When the entire syllabus is completed, a few lectures are devoted to discuss the previous years' question papers, thus preparing the students for the examination.
Practicals: Every practical session begins with detailed instructions, followed by students conducting the experiment/s. When all the students have collected the data, the observations are discussed. Any deviation from the expected trend in results is explained. The students are encouraged to graphically represent the data and record the experiment during class hours.
The students are asked to submit their record notebooks to the teacher/s for checking.
Week 1: Unit I
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Week 11: Mid Semester Break
Week 12: Unit VIII
Week 13: Unit IX
Week 14: Unit X
Week 15: Unit XI

Assessment Methods

Theory: The students are continuously evaluated based on a class test and the presentation given by each student. The answer scripts of the test are returned to the students and the test paper is discussed at length. Students who are absent for the test are allowed to appear for the test at a later date; the question paper is suitably modified for such students.
Each student in a class is given a different topic to prepare a PowerPoint presentation. All the remaining students listen to the presentation of each student, and peer students are also encouraged to ask questions. Presentations by students improves their reasoning and communication skills. The presentations of students are evaluated by the teacher based on the

content, effectiveness of the presentation, whether any new information has been added, and lastly on the answers given by students to the questions posed by the teacher.

An assignment can be given in place of the presentation.

The Internal Assessment has a break-up as 10 marks for the test, 10 marks for the presentation/ assignment and 5 marks for the attendance, and comprises 25 % of the total marks.

Practicals: For continuous evaluation two tests are conducted; one on the table work experiments for 10 marks, and the other on setups for 10 marks. The total marks obtained is scaled down to 10. Ten marks are allotted for record notebooks, and 5 marks for attendance. The Internal Assessment for practicals comprises 50 % of the total marks.

Assessment method

Unit No	**Course learning Outcome**	**Teaching and Learning Activity**	**Assessment Task**
Unit I:	Scope of Reproductive Biology contributions of G.B. Amici, W. Hofmeister, E. Strasburger, S.G. Nawaschin, P. Maheshwari, B.M. Johri, W.A. Jensen, J. Heslop-Harrison)	Activity :Class room lectures and Practical demonstration, experiments	Assessment: Hands on exercises, PPT, assignments, tests
Unit II:	Anther wall: Structure and functions, microsporogenesis, callose deposition and its significance.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit III:	Micro-gametogenesis; Pollen wall structure, NPC system; Palynology and scope; Pollen wall proteins; Pollen viability, storage and germination	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit IV:	Ovule Structure; Types; endothelium, obturator, aril, caruncle and hypostase; Female gametophyte– megasporogenesis (monosporic, bisporic and tetrasporic) and megagametogenesis (*Polygonum* type); Organization and ultrastructure of mature embryo sac	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit V:	Pollination types and significance; adaptations; structure of stigma and style; path of pollen tube in pistil; structure of pollen tube; double fertilization.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit VI:	Methods to overcome self-incompatibility: mixed pollination, bud pollination, stub	Class room lectures and Practical demonstration,	Hands on exercises, PPT, assignments, tests

	pollination; Intraovarian and in vitro pollination; Modification of stigma surface, parasexual hybridization; Cybrids	experiments	
Unit VII:	Endosperm types, development, structure and functions	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit VIII:	General pattern of development of dicot and monocot embryo; Suspensor: structure and functions; Embryo-endosperm relationship; Nutrition of embryo;	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit IX:	Seed structure, importance and dispersal mechanisms(Adaptations – Autochory, Anemochory, Hydrochory, Zoochory	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit X:	Polyembryony and apomixes	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit XI:	Pollen grain and ovules through pollen tube pathway method	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests

Keywords

Development, flowering, anther, pollen biology, ovule, gametogenesis, Pollination, fertilization, self -incompatibility, endosperm, seed, apomixis, polyembryony

Plant Physiology
(BHCC12)
Core Course - (CC) Credit:6

Course Objective(2-3)

The course aims at making students realize how plants function, namely the importance of water, minerals, hormones, and light in plant growth and development; understand transport mechanisms and translocation in the phloem, and appreciate the commercial applications of plant physiology.

Course Learning Outcomes

The students are able to correlate morphology, anatomy, cell structure and biochemistry with plant functioning. The link between theory and practical syllabus is established, and the employability of youth would be enhanced. The youth can also begin small-scale enterprises.

Unit 1

Plant water relationship (10 lectures)
Water potential and its components, water absorption by roots, aquaporins, pathway of water movement--symplast, apoplast, transmembrane pathways, root pressure, guttation, ascent of sap--cohesion-tension theory, transpiration and factors affecting transpiration, antitranspirants, mechanism of stomatal movement--starch-sugar hypothesis, proton transport theory, blue light stimulated response.

Unit 2

Mineral nutrition (8 lectures)
Essential and beneficial elements, macro- and micronutrients, methods of study and use of nutrient solutions (ash analysis, hydroponics, aeroponics), criteria for essentiality, mineral deficiency symptoms, roles of essential elements, chelating agents (including phytosiderophores).

Unit 3

Nutrient uptake (8 lectures)
Soil as a nutrient reservoir, transport of ions across cell membrane--passive absorption: simple (Fick's law) and facilitated diffusion (carrier and channel proteins), active absorption, proton ATPase pump, electrochemical gradient, ion flux, uniport, co-transport (symport, antiport), role of mycorrhizae (in brief).

Unit 4

Translocation in the phloem (6 lectures)
Experimental evidence in support of phloem as the site of sugar translocation, composition of phloem sap, aphid stylet technique, Pressure-Flow Model, phloem loading and unloading, source-sink relationship.

Unit 5

Plant growth regulators (16 lectures)
Discovery, chemical nature (basic structure, precursor), bioassay, physiological roles and commercial applications of Auxins, Gibberellins, Cytokinins, Abscisic Acid, Ethylene; brief introduction: mechanism of action of auxins; Brassinosteroids and Jasmonic acid (brief introduction).

Unit 6

Physiology of flowering (6 lectures)
Photoperiodism, concept of florigen, CO-FT Model for long-distance transport of flowering stimulus, ABC model of flowering (in brief), vernalization, seed dormancy (causes and methods to overcome dormancy).

Unit 7

Phytochrome (6 lectures)
Discovery, chemical nature, role of phytochrome in photomorphogenesis, low energy responses (LER) and high irradiance responses (HIR), mode of action.

Practical

1. Determination of osmotic potential of plant cell sap by plasmolytic method.
2. Determination of water potential of given tissue (potato tuber) by weight method.
3. Determination of water potential of given tissue (potato tuber) by falling drop method.
4. Study of the effect of light on the rate of transpiration in excised twig/ leaf.
5. Calculation of stomatal index and stomatal frequency from the two surfaces of leaves of a mesophyte and a xerophyte.
6. To calculate the area of an open stoma and percentage of leaf area open through stomata in a mesophyte and a xerophyte (any one surface).
7. To study the phenomenon of seed germination (effect of light and darkness).
8. To study the induction of amylase activity in germinating barley grains.

Demonstration experiments

1. To demonstrate suction due to transpiration.
2. Fruit ripening.
3. Rooting from cuttings.
4. Bolting experiment.
5. To demonstrate the delay of senescence by cytokinins

References

1. Bajracharya, D. (1999). *Experiments in Plant Physiology: A Laboratory Manual.* New Delhi, Delhi: Narosa Publishing House.
2. Bhatla, S.C., Lal, M.A. (2018). *Plant Physiology, Development and Metabolism.* Singapore: Springer Nature, Singapore Pvt. Ltd.
3. Hopkins, W. G., Huner, N. P. A. (2009). *Introduction to Plant Physiology*, 4th edition. New Delhi, Delhi: Wiley India Pvt. Ltd.
4. Kochhar, S.L., Gujral, S.K. (2017). *Plant Physiology: Theory and Applications.* New Delhi, Delhi: Foundation Books, Cambridge University Press India Pvt, Ltd.

Additional Resources:
6. Taiz, L., Zeiger, E., Moller, I. M., Murphy, A. (2018). *Plant Physiology and Development*, 6th edition. New York, NY: Oxford University Press, Sinauer Associates.

Teaching Learning Process

Theory: The theory topics are covered in lectures with the help of PowerPoint presentations and the chalkboard. Students are encouraged to ask questions. The reading list has been suitably upgraded.
When the entire syllabus is completed, a few lectures are devoted to discuss the previous years' question papers, thus preparing the students for the examination.
Practicals: Every practical session begins with detailed instructions, followed by students conducting the experiment/s. When all the students have collected the data, the observations are discussed. Any deviation from the expected trend in results is explained. The students are encouraged to graphically represent the data and record the experiment during class hours.

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The students are asked to submit their record notebooks to the teacher/s for checking.

Assessment Methods

Theory: The students are continuously evaluated based on a class test and the presentation given by each student. The answer scripts of the test are returned to the students and the test paper is discussed at length. Students who are absent for the test are allowed to appear for the test at a later date; the question paper is suitably modified for such students.
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An assignment can be given in place of the presentation.
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Practicals: For continuous evaluation two tests are conducted; one on the table work experiments for 10 marks, and the other on setups for 10 marks. The total marks obtained is scaled down to 10. Ten marks are allotted for record notebooks, and 5 marks for attendance. The Internal Assessment for practicals comprises 50 % of the total marks.
Assessment Task
Assessment method

Unit No	**Course learning Outcome**	**Teaching and Learning Activity**	**Assessment Task**
Unit I:	Water potential and its components, water absorption by roots, aquaporins, pathway of water movement, root pressure, guttation, ascent of sap, transpiration and factors affecting transpiration, antitranspirants, mechanism of stomatal movement--starch-sugar hypothesis, proton transport theory, blue light stimulated response.	Activity :Class room lectures and Practical demonstration, experiments	Assessment: Hands on exercises, PPT, assignments, tests
Unit II:	Essential and beneficial elements, macro- and micronutrients, methods	Class room lectures and Practical	Hands on exercises, PPT, assignments, tests

	of study and use of nutrient solutions (ash analysis, hydroponics, aeroponics), criteria for essentiality, mineral deficiency symptoms, roles of essential elements, chelating agents	demonstration, experiments	
Unit III:	Soil as a nutrient reservoir, transport of ions across cell membrane--passive absorption: simple (Fick's law) and facilitated diffusion (carrier and channel proteins), active absorption, proton ATPase pump, electrochemical gradient, ion flux, uniport, co-transport (symport, antiport), role of mycorrhizae	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit IV:	Experimental evidence in support of phloem as the site of sugar translocation, composition of phloem sap, aphid stylet technique, Pressure-Flow Model, phloem loading and unloading, source-sink relationship	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit V:	physiological roles and commercial applications of Auxins, Gibberellins, Cytokinins, Abscisic Acid, Ethylene; brief introduction: mechanism of action of auxins; Brassinosteroids and Jasmonic acid	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit VI:	Photoperiodism, concept of florigen, CO-FT Model for long-distance transport of flowering stimulus, ABC model of flowering (in brief), vernalization, seed dormancy	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit VII:	role of phytochrome in photomorphogenesis, low energy responses (LER) and high irradiance responses (HIR), mode of action	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests

Keywords

Movement of water, ascent of sap, transpiration, stomatal movements, mineral nutrients, active and passive transport, translocation, plant growth regulators, photoperiodism, photomorphogenesis

Plant Metabolism
(BHCC13)
Core Course - (CC) Credit:6

Course Objective(2-3)

1. A comprehensive study of different pathways including their biochemistry and to some extent the molecular details.
2. Current understanding of regulation and integration of metabolic processes in plants with reference to crop productivity.
3. Significance of metabolic pathways for metabolic engineering in producing transgenics.
4. To gain the knowledge of physiological and biochemical processes in the plant system

Course Learning Outcomes

- Concept and significance of metabolic redundancy in plants.
- Students will also be able to learn the similarity and differences in metabolic pathways in animals and plants.
- To have understanding of water and nutrient uptake and movement in plants, role of minerl elements, translocation of sugars, Role of various plant growth regulatoras, phytochrome cytochromes and phototropins, and flowering stimulus.

Unit 1

Concept in Metabolism (4lectures)
Introduction, anabolic and catabolic pathways, Principles of thermodynamics, coupled reactions

Unit 2

Enzymes (10 lectures)
Historical Background, structure, nomenclature and classification of enzymes, Mechanism of action (activation energy, lock and key, induced fit model), Michaelis Menten equation, enzyme inhibition (competitive, non-competitive and uncompetitive), factors affecting enzyme activity, role of regulatory enzymes, allosteric regulation and covalent modulation, isozymes and alloenzymes

Unit 3

Carbon assimilation (14 lectures)

Historical background, concept of light-action and absorption spectra, photosynthetic pigments, role of photosynthetic pigments (chlorophyll and accessory pigments (no structural details), antenna molecules and reaction centres, photochemical reactions, photosynthetic electron transport, photophosphorylation, PSI, PSII, Q cycle, CO2 reduction, photorespiration, C4 pathways, Crassulacean acid metabolism, factors affecting CO2 reduction

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Unit 4

Carbohydrate metabolism (2lectures)
Metabolite pool and exchange of metabolites, synthesis and catabolism of sucrose and starch (no structural details)

Unit 5

Carbon Oxidation (10 lectures)
Historical Background of Glycolysis and Krebs cycle, Glycolysis, fate of pyruvate- aerobic and anaerobic respiration and fermentation, regulation of glycolysis, oxidative pentose phosphate pathway, oxidative decarboxylation of pyruvate, regulation of Kerbs cycle, mitochondrial electron transport, oxidative phosphorylation, cyanide-resistant respiration, factors affecting respiration.

Unit 6

ATP synthesis (4lectures)
Mechanism of ATP synthesis, substrate level phosphorylation, chemiosmotic mechanism (oxidative and photophosphorylation), ATP synthase, Boyer’s conformational model, Racker’s experiement, Jagendorf’s experiement, role of uncouplers, P/O ratio

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Unit 7

Lipid Metabolism (8 lectures)
Synthesis and breakdown of triglycerides, -oxidation, glyoxylate cycle, gluconeogenesis and its role in mobilization of lipids during seed germination, -oxidation.

Unit 8

Nitrogen Metabolism (8 lectures)
Nitrate assimilation, biological nitrogen fixation (examples of legumes and non-legumes), Physiology and biochemistry of nitrogen fixation, Ammonia assimilation (GS-GOGAT), reductive amination and transamination.

Practical

1.To study the activity of urease enzyme and effect of substrate concentration and temperature on enzyme activity.
2. To study the activity of catalase enzyme and effect of heavy metal and pH on enzyme activity.
3. To study the activity of peroxidase and tryosinase and effect of inhibitor (phenylthiourea of tryosinase and sodium azide of peroxidase) on any one of the enzymes.
4. Chemical separation of photosynthetic pigments.
5. Experimental demonstration of Hill's reaction.
6. To demonstrate and verify Blackman's law of limiting factors.
7. To compare the rate of respiration in different parts of a plant (at least 3 parts).
8. To study activity of Nitrate reductase in leaves of two plant sources.
9. To study the activity of lipases in germinating oilseeds and demonstrate mobilization of lipids during germination.
10. Demonstration of fluorescence by isolated chlorophyll pigments.
11. Demonstration of absorption spectrum of photosynthetic pigments.
12. Demonstration of respiratory quotient (RQ).

References

1. Bhatla, S.C., Lal,M.A. (2018). *Plant Physiology, Development and Metabolism.* Singapore: Springer.
2. Buchanan, B.B., Gruissem, W. and Jones, R.L. (2015). *Biochemistry and Molecular Biology of Plants*, 2nd edition. New Jearsey, U.S.: Wiley Blackwell.
3. Hopkins, W.G., Huner, N. (2008). *Introduction of Plant Physiology*, 4th edition. New Jearsey, U.S.: John Wiley and sons.
4. Jones, R.,Ougham, H., Thomas,H.,Waaland, S. (2013). *The molecular life of plants*. Chichester, England: Wiley-Blackwell.

Additional Resources:
5. Nelson, D.L., Cox, M.M. (2017). *Lehninger Principle of Biochemistry*, 7th edition. New York, NY: W.H. Freeman, Macmillan learning.
6. Taiz, L., Zeiger, E., MØller, I.M., Murphy, A. (2015). *Plant Physiology and Development*, 6th edition. Massachusetts: Sinauer Associates Inc.Sunderlands.

Teaching Learning Process

The experiments included in the paper are performed individually or in group and are followed by group discussions and interjections.
The theory topics are covered in lectures with the help of PowerPoint presentations and the chalkboard. Students are encouraged to ask questions. The reading list has been suitably upgraded.
When the entire syllabus is completed, a few lectures are devoted to discuss the previous years' question papers, thus preparing the students for the examination.
Every practical session begins with detailed instructions, followed by students conducting the experiment/s. When all the students have collected the data, the observations are discussed. Any

deviation from the expected trend in results is explained. The students are encouraged to graphically represent the data and record the experiment during class hours.
The students are asked to submit their record notebooks to the teacher/s for checking.

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Assessment Methods

Students are continuously assessed during practical class.
Submission of class records is mandatory. This exercise develops scientific skill as well as methods of recording and presenting scientific data.
Assessment method

Unit No	**Course learning Outcome**	**Teaching and Learning Activity**	**Assessment Task**
Unit I:	anabolic and catabolic pathways, Principles of thermodynamics, coupled reactions	Activity :Class room lectures and Practical demonstration, experiments	Assessment: Hands on exercises, PPT, assignments, tests
Unit II:	Enzymes mechanism of action (activation energy, lock and key, induced fit model), Michaelis Menten equation, enzyme inhibition, factors affecting enzyme activity, role of regulatory enzymes, allosteric regulation and covalent modulation, isozymes and alloenzymes	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit III:	photosynthetic pigments, role of photosynthetic pigments	Class room lectures and Practical	Hands on exercises, PPT, assignments, tests

	(chlorophyll and accessory pigments (no structural details), antenna molecules and reaction centres, photochemical reactions, photosynthetic electron transport, photophosphorylation, PSI, PSII, Q cycle, CO2 reduction, photorespiration, C4 pathways, Crassulacean acid metabolism, factors affecting CO2 reduction	demonstration, experiments	
Unit IV:	Metabolite pool and exchange of metabolites, synthesis and catabolism of sucrose and starch	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit V:	Glycolysis, fate of pyruvate-aerobic and anaerobic respiration and fermentation, regulation of glycolysis, oxidative pentose phosphate pathway, oxidative decarboxylation of pyruvate, regulation of Kerbs cycle, mitochondrial electron transport, oxidative phosphorylation, cyanide-resistant respiration	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit VI:	Mechanism of ATP synthesis, substrate level phosphorylation, chemiosmotic mechanism (oxidative and photophosphorylation), ATP synthase, Boyer's conformational model, Racker's experiement, Jagendorf's experiement, role of uncouplers	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit VII:	Synthesis and breakdown of triglycerides, -oxidation, glyoxylate cycle, gluconeogenesis and its role in mobilization of lipids during seed germination, -oxidation.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit VIII:	Nitrate assimilation, biological nitrogen fixation (examples of legumes and non-legumes), Physiology and biochemistry of nitrogen fixation, Ammonia assimilation (GS-GOGAT), reductive amination and transamination.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests

Keywords

Bioenergetics, Coupled reactions, allosteric regulation, photochemical reaction, Glyoxylate cycle, Electron transport chain, ATP synthase, triglycerides, nitrogenase,Anabolism, catabolism, carbon assimilation, carbon oxidation, Lipid metabolism, nitrogen metabolism, signal transduction

Plant Biotechnology
(BHCC14)
Core Course - (CC) Credit:6

Course Objective(2-3)

1. The objective of the course is to give students new knowledge and widening of the knowledge acquired in other course by handling of classical and modern plant biotechnology processes, including tissue culture for healthy plants, plants with improved characteristics.
2. This course explores the use of biotechnology to both generate genetic variation in plants and to understand how factors at the cellular level contribute to the expression of genotypes and hence to phenotypic variation.
3. Understanding of biotechnological processes such as recombinant DNA technology and its applicative value in pharmaceuticals (vaccines, antibodies, antibiotics etc.), food industry (transgenic crops with improved qualities (nutraceuticals, industrial enzymes etc.), agriculture (biotic and abiotic stress tolerant plants, disease and pest resistant plants, improved horticultural varieties etc.), ecology (plants role in bioremediation). This knowledge is central to our ability to modify plant responses and properties for global food security and commercial gains in biotechnology and agriculture.
4. In the laboratory classes, students will perform some of the techniques currently used to generate information and detect genetic variation.

Course Learning Outcomes

The successful students will be able to:

- Learn the basic concepts, principles and processes in plant biotechnology.
- Have the ability of explanation of concepts, principles and usage of the acquired knowledge in biotechnological, pharmaceutical, medical, ecological and agricultural applications.
- Use basic biotechnological techniques to explore molecular biology of plants
- Explain how biotechnology is used to for plant improvement and discuss the biosefty concern and ethical issue of that use.

Unit 1

Plant Tissue Culture (12 lectures)
Historical perspective, Composition of media; Nutrient and hormone requirements (role of vitamins and hormones); Plasticity andTotipotency; Organogenesis; Embryogenesis (somatic and zygotic);

Unit 2

Protoplast isolation, culture and fusion; Tissue culture applications (micropropagation, androgenesis, virus elimination, secondary metabolite production, haploids, triploids and cybrids; Cryopreservation; Germplasm Conservation).

Unit 3

Recombinant DNA technology (32 lectures)
Restriction Endonucleases (History, Types I-IV, biological role and application); Restriction Mapping (Linear and Circular); Cloning Vectors: Prokaryotic (PUC 18 and pUJC19, pBR322. Ti plasmid, BAC); Lambda phage, Ml 3 phagemid, Cosmid, Shuttle vector; Eukaryotic Vectors (YAC and briefly PAC,).

Unit 4

Gene Cloning (Recombinant DNA. Bacterial Transformation and selection of recombinant clones, PCR and RT-PCRmediated gene cloning); Gene Construct; construction of genomic and cDNA libraries, screening DNA libraries to obtain gene of interest by genetic selection; complementation, colony hybridization; Probes-oligonucleotide, heterologous, PCR; Methods of gene transfer- Agrohacterium-mediated, Direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment: Selection of transgenics— selectable marker and reporter genes (Luciferase, GUS, GFP).DNA fingerprinting by RAPD and RFLP;

Unit 5

Applications of Biotechnology (16 lectures)
Engineering plants to overcome abiotic (drought and salt stress) and biotic stress Pest resistant (Bt-cotton) and herbicide resistant plants (RoundUp Ready soybean); Transgenic crops with improved quality traits (FlavrSavr tomato. Golden rice); Improved horticultural varieties (Moondust carnations); Role of transgenics in bioremediation (Superbug)

Unit 6

Molecular farming(Plants as bioreactors)for edible vaccines, antibodies, polymers, biodegradable plastics(PHA), biomass utilization andindustrial enzymes) (- amylase, phytase, lignocelluloses degrading enzymes); Biosatety concerns.

Practical

l. (a) Preparation of Murashige & Skoog's (MS) medium.
(b) Demonstration of in vitro sterilization and inoculation methods using leaf and nodal explants of tobacco, *Datura*, *Brassica* etc.
2. Study of anther. embryo and endosperm culture, micropropagation. somatic embryogenesis & artificial seeds through photographs.
3. Isolation of protoplasts.
4. Construction of restriction map of circular and linear DNA from the data provided.
5. Study of methods of gene transfer through photographs: *Agrobacterium*-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment.
6. Study of steps of genetic engineering for production of *Bt* cotton, Golden rice, FlavrSavr tomato through photographs.
7. Isolation of plasmid DNA.
8. Restriction digestion and gel electrophoresis of plasmid DNA (demonstration/ photograph).
9. Calculate the percentage similarity between different cultivars of a species using RAPD profile. Construct a dendrogram and interpret results.

References

1. Bhojwani, S.S., Bhatnagar, S.P. (2011). *The Embryology of Angiosperms*, 5th edition. New Delhi, Delhi: Vikas Publication House Pvt. Ltd.
2. Bhojwani, S.S., Razdan, M.K., (1996). *Plant Tissue Culture: Theory and Practice.* Amsterdam, Netherlands: Elsevier Science.
2. Glick, B.R., Pasternak, J..J.(2010). *Molecular Biotechnology: Principles and Applications.* Washington, U.S.: ASM Press.
4. Snustad, D.P.,Simmons, M.J. (2010). *Principles of Genetics*, 5th edition. Chichester, England: John Wiley and Sons.

Additional Resources

1. Stewart, C.N. Jr. (2008). *Plant Biotechnology and Genetics: Principles, Techniques and Applications.* New Jearsey, U.S.: John Wiley & Sons Inc.

Teaching Learning Process

1) Problem oriented learning
2) Individual seminar
3) Presentation and interpretation to other students
4) Discussion of published research articles on the selected topics
5) Practical will introduce the students to a range of tools and techniques of biotechnology
Week 1: Unit I
Week 2: Unit I
Week 3: Unit II
Week 4: Unit II

Week 5: Unit III
Week 6: Unit III
Week 7: Unit IV
Week 8: Unit IV
Week 9: Unit IV
Week 10: Mid semester Exam
Week 11: Mid Semester Break
Week 12: Unit V
Week 13: Unit V
Week 14: Unit VI
Week 15: Unit VI

Assessment Methods

Assessment must encourage and reinforce learning.
Assessment must enable robust and fair judgments about student performance.
Assessment practices must be fair and equitable to students and give them the opportunity to demonstrate what they have learned.
Assessment must maintain academic standards.
Assessment will be by written class test, assignment, project work, viva for internal assessment and written theory and practical examination for university evaluation.

Assessment method

Unit No	**Course learning Outcome**	**Teaching and Learning Activity**	**Assessment Task**
Unit I:	Composition of media; Nutrient and hormone requirements (role of vitamins and hormones); Plasticity andTotipotency; Organogenesis; Embryogenesis	Activity :Class room lectures and Practical demonstration, experiments	Assessment: Hands on exercises, PPT, assignments, tests
Unit II:	Protoplast isolation, culture and fusion; Tissue culture applications (micropropagation, androgenesis, virus elimination, secondary metabolite production, haploids, triploids and cybrids; Cryopreservation; Germplasm Conservation).	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit III:	Restriction Endonucleases (History, Types I-IV, biological role and application); Restriction Mapping (Linear and Circular); Cloning Vectors: Prokaryotic (PUC 18 and pUJC19, pBR322. Ti plasmid,	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests

	BAC); Lambda phage, Ml 3 phagemid, Cosmid, Shuttle vector; Eukaryotic Vectors (YAC and briefly PAC,).		
Unit IV:	Gene Cloning (Recombinant DNA. Bacterial Transformation and selection of recombinant clones, PCR and RT-PCRmediated gene cloning); Gene Construct; construction of genomic and cDNA libraries, screening DNA libraries to obtain gene of interest by genetic selection; complementation, colony hybridization; Probes- oligonucleotide, heterologous, PCR; Methods of gene transfer- Agrohacterium-mediated, Direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment: Selection of transgenics— selectable marker and reporter genes (Luciferase, GUS, GFP).DNA fingerprinting by RAPD and RFLP	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit V:	Engineering plants to overcome abiotic (drought and salt stress) and biotic stress Pest resistant (Bt-cotton) and herbicide resistant plants (RoundUp Ready soybean); Transgenic crops with improved quality traits (FlavrSavr tomato. Golden rice); Improved horticultural varieties (Moondust carnations); Role of transgenics in bioremediation (Superbug)	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit VI:	Molecular farming(Plants as bioreactors)for edible vaccines, antibodies, polymers, biodegradable plastics(PHA), biomass utilization andindustrial enzymes) (- amylase, phytase, lignocelluloses degrading enzymes); Biosafety concerns	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests

Keywords

Tissue culture, micropropagation, organogenesis, totipotency, cryopreservation, recombinant DNA technology, Gene cloning , gene transfer, , electroporation microinjection, DNA library, transgenic crops, Humulin, biosafety, edible vaccines,

Analytical Techniques in Plant Sciences
(BHDS1)
Discipline Specific Elective - (DSE) Credit:6

Course Objective(2-3)

To gain the knowledge on various techniques and instruments used for the study of plant biology

Course Learning Outcomes

Understanding of principles and use of light, confocal transmission and electron microscopy, centrifugation, spectrophotometry, chromatography, x-ray diffraction technique and chromatography techniques

Unit 1

Imaging and related techniques (15 lectures)
Principles of microscopy; Light microscopy; Fluorescence microscopy; Confocal microscopy; Use of fluorochromes: (a) Flow cytometry (FACS); (b) Applications of fluorescence microscopy: Chromosome banding, FISH, chromosome painting; Transmission and Scanning electron microscopy – sample preparation for electron microscopy, cryofixation, negative staining, shadow casting, freeze fracture, freeze etching.

Unit 2

Cell fractionation (8 lectures)
Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, CaCl2 gradient, analytical centrifugation, ultracentrifugation, marker enzymes.

Unit 3

Radioisotopes (4 lectures)
Use in biological research, auto-radiography, pulse chase experiment.

Unit 4

Spectrophotometry (4 lectures)
Principle and its application in biological research.

Unit 5

Chromatography (8 lectures)
Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ion-exchange chromatography; Molecular sieve chromatography; Affinity chromatography.

Unit 6

Characterization of proteins and nucleic acids (6 lectures)
Mass spectrometry; X-ray diffraction; X-ray crystallography; Characterization of proteins and nucleic acids; Electrophoresis: AGE, PAGE, SDS-PAGE

Practical

1.Study of Blotting techniques: Southern, Northern and Western, DNA fingerprinting, DNA sequencing, PCR through photographs.
2. Demonstration of ELISA.
3. To separate nitrogenous bases by paper chromatography.
4. To separate sugars by thin layer chromatography.
5. Isolation of chloroplasts by differential centrifugation.
6. To separate chloroplast pigments by column chromatography.
7. To estimate protein concentration through Lowry's methods.
8. To separate proteins using PAGE.
9. To separation DNA (marker) using AGE.
10. Study of different microscopic techniques using photographs/micrographs (freeze fracture, freeze etching, negative staining, positive staining, fluorescence and FISH).
11. Preparation of permanent slides (double staining).

References

1. Plummer, D.T. (1996). *An Introduction to Practical Biochemistry*, 3rd edition. New Delhi, Delhi: Tata McGraw-Hill Publishing Co. Ltd.
2. Ruzin, S.E. (1999). *Plant Microtechnique and Microscopy*. New York, NY: Oxford University Press.

Teaching Learning Process

Theory: The theory topics are covered in lectures with the help of PowerPoint presentations and the chalkboard. Students are encouraged to ask questions. The reading list has been suitably upgraded.

When the entire syllabus is completed, a few lectures are devoted to discuss the previous years' question papers, thus preparing the students for the examination.

Practicals: Every practical session begins with detailed instructions, followed by students conducting the experiment/s. When all the students have collected the data, the observations are discussed. Any deviation from the expected trend in results is explained. The students are encouraged to graphically represent the data and record the experiment during class hours.

The students are asked to submit their record notebooks to the teacher/s for checking.

Weekly Plan

Week 2: Unit I

Week 3: Unit I

Week 4: Unit II

Week 5: Unit II

Week 6: Unit III

Week 7: Unit III

Week 8: Unit IV

Week 9: Instrumentation lab visit

Week 10: Mid semester Exam

Week 11: Mid Semester Break

Week 12: Unit V

Week 13: Unit VI

Week 14: Unit VI

Assessment Methods

Theory: The students are continuously evaluated based on a class test and the presentation given by each student. The answer scripts of the test are returned to the students and the test paper is discussed at length. Students who are absent for the test are allowed to appear for the test at a later date; the question paper is suitably modified for such students.

Each student in a class is given a different topic to prepare a PowerPoint presentation. All the remaining students listen to the presentation of each student, and peer students are also encouraged to ask questions. Presentations by students improves their reasoning and communication skills. The presentations of students are evaluated by the teacher based on the content, effectiveness of the presentation, whether any new information has been added, and lastly on the answers given by students to the questions posed by the teacher.

An assignment can be given in place of the presentation.

The Internal Assessment has a break-up as 10 marks for the test, 10 marks for the presentation/ assignment and 5 marks for the attendance, and comprises 25 % of the total marks.

Practicals: For continuous evaluation two tests are conducted; one on the table work experiments for 10 marks, and the other on setups for 10 marks. The total marks obtained is scaled down to 10. Ten marks are allotted for record notebooks, and 5 marks for attendance. The Internal Assessment for practicals comprises 50 % of the total marks.

Unit No	**Course learning Outcome**	**Teaching and Learning Activity**	**Assessment Task**
Unit I:	Principles of microscopy; Light microscopy; Fluorescence microscopy; Confocal microscopy; Use of fluorochromes: (a) Flow cytometry (FACS); (b) Applications of fluorescence microscopy: Chromosome banding, FISH, chromosome painting; Transmission and Scanning electron microscopy – sample preparation for electron microscopy, cryofixation, negative staining, shadow casting, freeze fracture, freeze etching.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit II:	Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, CaCl2 gradient, analytical centrifugation, ultracentrifugation, marker enzymes.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit III:	Radioisotopes and their Use in biological research, auto-radiography, pulse chase experiment.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit IV:	Principle and its application in biological research.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit V:	Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ion-exchange chromatography; Molecular sieve chromatography; Affinity chromatography.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit VI:	Mass spectrometry; X-ray diffraction; X-ray crystallography; Characterization of proteins and nucleic acids; Electrophoresis: AGE, PAGE, SDS-PAGE	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests

Keywords

Microscopy, Flow cytometry, Chromosome banding, FISH, SCM, Centrifugation, radioisotopes, spectrophotometry, chromatography, electrophoresis, PAGE, mass spectrometry

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Bioinformatics
(BHDS4)
Discipline Specific Elective - (DSE) Credit:6

Course Objective(2-3)

A computer-based approach is now central to biological research. Bioinformatics operates at the intersection of biology and informatics and has a strong mathematical component. Training students in various aspects of Bioinformatics is the objective of this course.

Course Learning Outcomes

With a working knowledge of the practical and theoretical concepts of bioinformatics, you will be well qualified to progress onto advanced graduate study. The portfolio of skills developed on the programme is also suited to academic research or work within the bioinformatics industry as well as range of commercial settings.

Unit 1

Introduction to Bioinformatics (10 lectures)

Computer fundamentals - programming languages in bioinformatics, role of supercomputers in biology. Historical background. Scope of bioinformatics - Genomics, Transcriptomics, Proteomics, Metabolomics, Molecular Phylogeny, computer aided Drug Design (structure based and ligand based approaches), Systems Biology and Functional Biology. Applications and Limitations of bioinformatics.

Unit 2

Biological databases (5 lectures)
Introduction to biological databases - primary, secondary and composite databases, NCBI, nucleic acid databases (GenBank, EMBL, DDBJ, NDB), protein databases (PIR, Swiss-Prot, TrEMBL, PDB), metabolic pathway database (KEGG, EcoCyc, and MetaCyc), small molecule databases (PubChem, Drug Bank, ZINC, CSD). Structure viewers (Ras Mol, J mol).

Unit 3

Data Generation and Data Retrieval (5 lectures)
Generation of data (Gene sequencing, Protein sequencing, Mass spectrometry, Microarray), Sequence submission tools (BankIt, Sequin, Webin); Sequence file format (flat file, FASTA, GCG, EMBL, Clustal, Phylip, Swiss-Prot); Sequence annotation; Data retrieval systems (SRS, Entrez)

Unit 4

Basic concepts of Sequence alignment (10 lectures)
Similarity, identity and homology. Alignment – local and global alignment, pairwise and multiple sequence alignments, alignment algorithms. Methods of Alignment (Dot matrix, Dynamic Programming, BLAST and FASTA); Scoring Matrices/ Amino acid substitution matrices (PAM and BLOSUM), and CLUSTALW.

Unit 5

Phylogenetic analysis (10 lectures)
Construction of phylogenetic tree, dendrograms, methods of construction of phylogenetic trees - maximum parsimony, maximum likelihood and distance methods.

Unit 6

Applications of Bioinformatics (20 lectures)
Functional genomics (genome-wide and high throughput approaches to gene and protein function), Protein structure prediction and analysis- Levels of protein structure. gene prediction methods and tools. Structural Bioinformatics in Drug Discovery, Quantitative structure-activity relationship (QSAR) techniques in Drug Design, Microbial genome applications, Crop improvement.

Practical

1. Sequence retrieval (protein and gene) from NCBI.
2. Structure download (protein and DNA) from PDB.
3. Molecular file formats - FASTA, GenBank, Genpept, GCG, CLUSTAL, Swiss-Prot, FIR.
4. Molecular viewer by visualization software.
5. Translate a nucleotide sequence and select the correct reading frame of the polypeptide from the output sequences.
6. Predict the structure of protein from its amino acid sequence.
7. BLAST suite of tools for pairwise alignment.
8. Sequence homology and Gene annotation.
9. Construction of phylogenetic tree.

10. Generating phylogenetic tree using PHYLIP.
11. Gene prediction using GENSCAN and GLIMMER.

References

1. Ghosh, Z., Mallick, B. (2008). *Bioinformatics – Principles and Applications*, 1st edition. New Delhi, Delhi: Oxford University Press.
2. Baxevanis, A.D. and Ouellette, B.F., John (2005). *Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins*, 3rd edition. New Jersey, U.S.: Wiley & Sons, Inc.
3. Roy, D. (2009). *Bioinformatics*, 1st edition. New Delhi, Delhi: Narosa Publishing House.
4. Andreas, D., Baxevanis, B.F., Francis, Ouellette. (2004). *Bioinformatics: A practical guide to the analysis of genes and proteins*, 3rd edition. New Jersey, U.S.: John Wiley and Sons.

Additional Resources:

1. Pevsner J. (2009). *Bioinformatics and Functional Genomics*, 2nd edition. New Jersey, U.S.: Wiley Blackwell.
2. Xiong J. (2006). *Essential Bioinformatics,*1st edition. Cambridge, U.K.: Cambridge University Press.

Teaching Learning Process

Multimedia tutorials and hands on training over biological data using world wide web services.
Interactive classroom teaching of mathematical modelings and Computer programs.
Weekly Lesson Plan
Week 1: Unit I
Week 2: Unit I
Week 3: Unit I
Week 4: Unit II
Week 5: Unit II
Week 6: Unit III
Week 7: Unit III
Week 8: Unit IV
Week 9: Unit V
Week 10: Mid semester Exam
Week 11: Mid Semester Break
Week 12: Unit V
Week 13: Unit VI
Week 14: Unit VI
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Assessment Methods

Theoretical tests with the help of assignments, project works, presentations, and through practical examinations.

Assessment Task

Unit No	Course learning Outcome	Teaching and Learning Activity	Assessment Task
Unit I:	Computer fundamentals - programming languages in bioinformatics, role of supercomputers in biology. Historical background. Scope of bioinformatics - Genomics, Transcriptomics, Proteomics, Metabolomics, Molecular Phylogeny, computer aided Drug Design (structure based and ligand based approaches), Systems Biology and Functional Biology. Applications and Limitations of bioinformatics.	Class room lectures and Practical demonstration, experiments , generation and analysis of data	Hands on exercises, PPT, assignments, tests,
Unit II:	Introduction to biological databases - primary, secondary and composite databases, NCBI, nucleic acid databases (GenBank, EMBL, DDBJ, NDB), protein databases (PIR, Swiss-Prot, TrEMBL, PDB), metabolic pathway database (KEGG, EcoCyc, and MetaCyc), small molecule databases (PubChem, Drug Bank, ZINC, CSD). Structure viewers (Ras Mol, J mol).	Class room lectures and Practical demonstration, experiments, generation and analysis of data	Hands on exercises, PPT, assignments, tests
Unit III:	Generation of data (Gene sequencing, Protein sequencing, Mass spectrometry, Microarray), Sequence submission tools (BankIt, Sequin, Webin); Sequence file format (flat file, FASTA, GCG, EMBL, Clustal, Phylip, Swiss-Prot); Sequence annotation; Data retrieval systems (SRS, Entrez)	Class room lectures and Practical demonstration, experiments , generation and analysis of data	Hands on exercises, PPT, assignments, tests
Unit IV:	Similarity, identity and homology. Alignment – local and global alignment, pairwise and multiple sequence alignments, alignment algorithms. Methods of Alignment (Dot matrix, Dynamic Programming, BLAST and FASTA); Scoring Matrices/ Amino acid substitution matrices (PAM and	Class room lectures and Practical demonstration, experiments , generation and analysis of data	Hands on exercises, PPT, assignments, tests

	BLOSUM), and CLUSTALW.		
Unit V:	Construction of phylogenetic tree, dendrograms, methods of construction of phylogenetic trees - maximum parsimony, maximum likelihood and distance methods.	Class room lectures and Practical demonstration, experiments , generation and analysis of data	Hands on exercises, PPT, assignments, tests
Unit VI:	Functional genomics (genome-wide and high throughput approaches to gene and protein function), Protein structure prediction and analysis- Levels of protein structure. gene prediction methods and tools. Structural Bioinformatics in Drug Discovery, Quantitative structure-activity relationship (QSAR) techniques in Drug Design, Microbial genome applications, Crop improvement.	Class room lectures and Practical demonstration, experiments , generation and analysis of data	Hands on exercises, PPT, assignments, tests

Keywords

Biological Databases, Sequence Alignment, Phylogenetics Analysis, Protein Structure prediction and analysis.

Biostatistics
(BHDS2)
Discipline Specific Elective - (DSE) Credit:6

Course Objective(2-3)

To have knowledge of analysis of scientific data

Course Learning Outcomes

Understanding of interpreting the scientific data that is generated during scientific experiments. It is the responsibility of biostatisticians and other experts to consider the variables in subjects to understand them, and to make sense of different sources of variation. In essence, the goal of biostatistics is to disentangle the data received and make valid inferences that can be used to solve problems in public health. Biostatistics uses the application of statistical methods to conduct research in the areas of biology, public health, and medicine. Many times, experts in biostatistics collaborate with other scientists and researchers.

Unit 1

Biostatistics - definition - statistical methods - basic principles. Variables -measurements, functions, limitations and uses ofstatistics. (8 lectures)

Unit 2

Collection of data primary and secondary - types and methods of data collection procedures - merits and demerits. Classification - tabulation and presentation of data – sampling methods. (12 lectures)

Unit 3

Measures of central tendency - mean, median, mode, merits & demerits of harmonic and geometric mean - . Measures of dispersion - range, standard deviation, mean deviation, standard error, skewness and kurtosis, quartile deviation –merits and demerits; Co- efficient of variations. (13 lectures)

Unit 4

Correlation - types and methods of correlation, regression, simple regression equation,

fitting prediction, similarities and dissimilarities of correlation and regression.
(10 lectures)

Unit 5

Statistical inference - hypothesis - simple hypothesis - student’t’ test - chi square test, Ftest.
(10 lectures)

Unit 6

Basic concept of probability, Introduction to bionomial, poisson and Normal distribution; Uses of advance softwares (MS-excel, SPSS, Sigmaplot and R) in modern biostatistics. (6 Lectures)

Practical

1) Classification - tabulation and presentation of data
2) Calculation of mean, mode, median, standard deviation, quartile deviation, standard error and coefficient of variance
3) Calculation of correlation coefficient values by Karl Pearson’s and Spearman Rank methods
4) Statistical inference - hypothesis – student ‘t’ test - chi square test
5) Addition and multiple rules of probability
6) One way analysis of variance
7) Uses of software in biostatistics

References

1. Bishop, O.N., (1967). *Statistics for Biology*. Boston, Massachusetts: Houghton Mifflin Company.
2. Campbell, R.C. (1998). *Statistics for Biologists*. Cambridge, U.S.A.: Cambridge University Press.
3. Danniel, W.W. (1987). *Biostatistic.* New York,NY: John Wiley Sons.
4. Freedman, P. (1949). *The Principles of scientific research.* New York, NY: Pergamon Press.
5. Khan, I.A., Khanum, A. (2004). *Fundamentals of Biostatistics*, 5th edition. Hyderabad: Ukaaz publications.

Additional Resources:
6. Pandey, M. (2015). *Biostatistics Basic and Advanced.* New Delhi, Delhi: M V Learning.

7. Selvin, S., (1991). *Statistical Analysis of epidemiological data.* New York, NY: New York University Press.

8. Sundarrao, P.S.S., Richards, (1996). *An introduction to Biostatistics*, 3rd edition. Vellore, Tamil Nadu: J. Christian Medical College.

9. Zar, J.H. (2012). *Biostatistical Analysis*, 4th edition. London, London: Pearson Publication.

Teaching Learning Process

Theory: The theory topics are covered in lectures with the help of PowerPoint presentations and the chalkboard. Students are encouraged to ask questions. The reading list has been suitably upgraded.
When the entire syllabus is completed, a few lectures are devoted to discuss the previous years' question papers, thus preparing the students for the examination.
Practicals: Every practical session begins with detailed instructions, followed by students conducting the experiment/s. When all the students have collected the data, the observations are discussed. Any deviation from the expected trend in results is explained. The students are encouraged to graphically represent the data and record the experiment during class hours.
The students are asked to submit their record notebooks to the teacher/s for checking.
Weekly Plan
Week 2: Unit I
Week 3: Unit I
Week 4: Unit II
Week 5: Unit II
Week 6: Unit III
Week 7: Unit III
Week 8: Unit IV
Week 9: Unit V
Week 10: Mid semester Exam
Week 11: Mid Semester Break
Week 12: Unit V
Week 13: Unit VI
Week 14: Unit VI

Assessment Methods

Theory: The students are continuously evaluated based on a class test and the presentation given by each student. The answer scripts of the test are returned to the students and the test paper is discussed at length. Students who are absent for the test are allowed to appear for the test at a later date; the question paper is suitably modified for such students.
Each student in a class is given a different topic to prepare a PowerPoint presentation. All the remaining students listen to the presentation of each student, and peer students are also encouraged to ask questions. Presentations by students improves their reasoning and

communication skills. The presentations of students are evaluated by the teacher based on the content, effectiveness of the presentation, whether any new information has been added, and lastly on the answers given by students to the questions posed by the teacher.
An assignment can be given in place of the presentation.
The Internal Assessment has a break-up as 10 marks for the test, 10 marks for the presentation/ assignment and 5 marks for the attendance, and comprises 25 % of the total marks.
Practicals: For continuous evaluation two tests are conducted; one on the table work experiments for 10 marks, and the other on setups for 10 marks. The total marks obtained is scaled down to 10. Ten marks are allotted for record notebooks, and 5 marks for attendance. The Internal Assessment for practicals comprises 50 % of the total marks.
Assessment Task

Unit No	Course learning Outcome	Teaching and Learning Activity	Assessment Task
Unit I:	Biostatistics - definition - statistical methods - basic principles. Variables -measurements, functions, limitations and uses ofstatistics.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit II:	Collection of data primary and secondary - types and methods of data collection procedures - merits and demerits. Classification - tabulation and presentation of data – sampling methods.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit III:	Measures of central tendency - mean, median, mode, merits & demerits of harmonic and geometric mean - . Measures of dispersion - range, standard deviation, mean deviation, standard error, skewness and kurtosis, quartile deviation –merits and demerits; Co- efficient of variations.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit IV:	Correlation - types and methods of correlation, regression, simple regression equation, fitting prediction, similarities and dissimilarities of correlation and regression.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit V:	Statistical inference - hypothesis - simple hypothesis - student’t’ test - chi square test, Ftest.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit VI:	Basic concept of probability, Introduction to bionomial, poisson and Normal distribution; Uses of advance softwares (MS-excel, SPSS, Sigmaplot and R) in modern biostatistics.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests

Keywords

Biological database, Sequence database, ,NCBI, Sequence alignment, melecular Phylogeny QSAR, crop improvement ,

Industrial and Environmental Microbiology
(BHDS3)
Discipline Specific Elective - (DSE) Credit:6

Course Objective (2-3)

1. To introduce students with the industrial microbiology: concepts, principles, scope and application
2. To introduce students with the environmental microbiology: concepts, principles, scope and application

Course Learning Outcomes

Upon successful completion of the course, students are expected to be able to:

1. Understand how microbiology is applied in manufacturing of industrial products
2. Know about design of bioreactors, factors affecting growth and production
3. Understand the rationale in medium formulation & design for microbial fermentation, sterilization of medium and air
4. Comprehend the different types of fermentation processes
5. Comprehend the techniques and the underlying principles in upstream and down- stream processing
6. Learn the occurrence, abundance and distribution of microorganism in the environment and their role in the environment and also learn different methods for their detection
7. Understand various biogeochemical cycles – Carbon and Nitrogen, and microbes involved
8. Understand the basic principles of environment microbiology and application of the same in solving environmental problems – waste water treatment and bioremediation
9. Comprehend the various methods to determine the quality of water

Unit 1

Scope of microbes in industry and environment; institutes of microbial research (4 lectures)

Unit 2

Bioreactors/Fermenters and fermentation processes (12 lectures)

Solid-state and liquid-state (stationary and submerged) fermentations; Batch and continuous Fermentations; Components of a typical bioreactor, Types of bioreactors: laboratory, pilotscale and production fermenters; Constantly stirred tank fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air-lift fermenter.

Unit 3

Microbial production of industrial products (14 lectures)
Microorganisms involved, microorganisms generally regarded as safe (GRAS), media, fermentation conditions, downstream processing and uses; Filtration, centrifugation, cell disruption, solvent extraction, precipitation and ultrafiltration, lyophilization, spray drying; production of industrially important products: enzyme (amylase); organic acid (citric acid); alcohol (ethanol); antibiotic (penicillin)

Unit 4

Microbial enzymes of industrial interest and enzyme immobilization (8 lectures)
Overview of enzymes used for industrial applications, Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes: glucose isomerase and penicillin acylase

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Unit 5

Microbes and quality of environment. (6 lectures)
Distribution of microbes in air, soil and water; isolation of microorganisms from soil, air and water.

Unit 6

Microbial flora of water. (10 lectures)
Water pollution: various sources and control measures; role of microbes in sewage and domestic waste water treatment systems. Microorganisms as indicators of water quality: coliforms and fecal coliforms.

Practical

1. Principles and functioning of instruments in microbiology laboratory (autoclave, laminar air flow, incubators, types of fermenters)
2. Preparation of different culture media (Nutrient medium/ Luria Bertani medium/Potato dextrose medium/Czapek Dox medium)

3. Hydrolysis of casein / starch by microorganisms
4. Alcohol production by yeast using sugar/ jaggery
5. Serial dilution method for isolation of microorganisms from water and soil and study of aeromicroflora.
6. Determination of BOD, COD, TDS and TOC of water samples
7. Determination of coliforms in water samples using eosin methylene blue (EMB) medium
8. A visit to any educational institute/ industry to see an industrial fermenter, and other downstream processing operations and a report to be submitted.

References

Suggested Readings

1. Pelczar, M.J. Jr., Chen E.C. S., Krieg, N.R. (2010). Microbiology: An application based approach. Tata McGraw Hill Education Pvt. Ltd., Delhi.
2. Tortora, G.J., Funke, B.R., Case. C.L. (2007). Microbiology. Pearson Benjamin Cummings, San Francisco, U.S.A. 9th edition
3. Peter F Stanbury, Allan Whitaker, Stephen J Hall, (2000). *Principles of Fermentation Technology* **.** Oxford: Butterworth-Heinemann,
4. Patel, A.H. (2011). Industrial Microbiology, New Delhi: Laxmi Publications,
5. PK Mohapatra, (2008). *Textbook of Environmental Microbiology*. New Delhi, IK International.
6. Jean-Claude Bertrand, Pierre Caumette, Philippe Lebaron, Robert Matheron, Philippe Normand, Télesphore Sime-Ngando.(2015). *Environmental Microbiology: Fundamentals and Applications,* UK:Springer

Additional Resources:

1. Cassida, L.E.. (1968). *Industrial Microbiology*, New Jersey: John Wiley & Sons
2. Atlas, R.M., Bartha, R. (1998), Microbial Ecology, Tx: USA, Benjamin / Cummings Publishing Company.
3. Sharma, P.D. (2005). *Environmental Microbiology*, Meerut: Rastogi Publications

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Teaching Learning Process

i) The acquired knowledge in the classroom will be integrated with practical classes to impart a sound understanding of the course
ii) More emphasis on hands on practical sessions
iii) Visits to various research institutes/industries to understand the application of microbes for commercial productions.

iv)Visits to industries/ research institutions working towards mitigation of various environmental issues through microbial application.

v) Students will be motivated to become self-directed learners by being able to monitor and adjust their approach towards learning of the course.

Teaching Learning Plan

Week 1: Unit I Week 2: Unit I Week 3: Unit II Week 4: Unit II Week 5: Unit III Week 6: Unit III Week 7: Unit III Week 8: Unit IV Week 9: Unit IV Week 10: Mid semester Exam Week 11: Mid Semester Break Week 12: Unit V Week 13: Unit VI Week 14: Unit VI Week 15: Unit VII

Assessment Methods

i. Continuous evaluation of the progress of students
ii. Field based projects/reports
iii. Interactive sessions/ presentations
iv. Semester end evaluation

ASSESSMENT METHOD

Unit No	Coure learning Outcome	Teaching and Learning Activity	Assessment Task
I	**Scope of microbes in industry and environment**	Class room lectures and Practical demonstration, experiments	Hands on excercises, PPT, assignments, tests
II	**Bioreactors/Fermenters and fermentation processes** Solid-state and liquid-state (stationary and submerged) fermentations; Batch and continuous Fermentations; Components of a typical bioreactor, Types of bioreactors: laboratory, pilotscale and production fermenters; Constantly stirred tank fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air-lift fermenter.	Class room lectures and Practical demonstration, experiments, industry/institute visit to learn the structure and functioning of various fermenters	Hands on excercises, PPT, assignments, tests, Industry/ institute visit report
III	**Microbial production of industrial products** Microorganisms involved, microorganisms generally regarded as safe (GRAS), media, fermentation conditions, downstream processing	Class room lectures and Practical demonstration, experiments, industry/institute visit to learn the role of	Hands on excercises, PPT, assignments, tests, Industry/ institute visit report

	and uses; Filtration, centrifugation, cell disruption, solvent extraction, precipitation and ultrafiltration, lyophilization, spray drying; production of industrially important products: enzyme (amylase); organic acid (citric acid); alcohol (ethanol); antibiotic (penicillin)	microbes in production of various products	
IV	**Microbial enzymes of industrial interest and enzyme immobilization** Overview of enzymes used for industrial applications, Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes: glucose isomerase and penicillin acylase**.**	Class room lectures and Practical demonstration, experiments	Hands on excercises, PPT, assignments, tests
V	**Microbes and quality of environment.** Distribution of microbes in air, soil and water; isolation of microorganisms from soil, air and water.	Class room lectures and Practical demonstration, experiments	Hands on excercises, PPT, assignments, tests
VI	**Microbial flora of water.** Water pollution: various sources and control measures; role of microbes in sewage and domestic waste water treatment systems. Microorganisms as indicators of water quality: coliforms and fecal coliforms.	Class room lectures and Practical demonstration, experiments, visit to a sewage treatment plant to observe the role of microbes	Hands on excercises, PPT, assignments, tests, field visit report
VII	**Microbes in agriculture and remediation of contaminated soils.** Biological fixation (Carbon and Nitrogen); bioremediation of contaminated soils	Class room lectures and Practical demonstration, experiments, field visit	Hands on excercises, PPT, assignments, tests, field visit report

Keywords

Industrial microbiology, environmental microbiology, microbes, bioreactors, fermenters, fermentation, upstream processing, downstream processing, microbial enzymes, enzyme immobilization, aeromicroflora, water pollution, coliform, biological fixation, bioremediation

Natural Resource Management
(BHDS9)
Discipline Specific Elective - (DSE) Credit:6

Course Objective (2-3)

To introduce the students with various Natural Resources and their management strategies.
To make them aware about the contemporary practices and efforts (national and international) in resources management.

Course Learning Outcomes

It acquaint the students with various Natural Resources- their availability, causes of depletion, conservation, sustainable utilization and their management strategies. The students will be able to evolve strategies for sustainable natural resources management. The students will also have the knowledge of national and international initiatives, and policies adopted in natural resources management.

Unit 1

Natural resources (2 lectures)
Definition and types.

Unit 2

Sustainable utilization (8 lectures)
Concept, approaches (economic, ecological and socio-cultural).

Unit 3

Land (8 lectures)
Utilization (agricultural, pastoral, horticultural, silvicultural); Soil degradation (magnitude of problem and cause) and management strategies; Restoration of degraded lands.

Unit 4

Water (8 lectures)
Fresh water (rivers, lakes, groundwater, aquifers, watershed); Marine; Estuarine; Wetlands; Threats and management strategies, Ramsar convention.

Unit 5

Biological Resources (12 lectures)

Biodiversity-definition and types; Significance; Threats; Management strategies; Bioprospecting; IPR; CBD; National Biodiversity Action Plan).

Unit 6

Forests (6 lectures)
Definition, Cover and its significance (with special reference to India); Major and minor forest products; Depletion, Biological Invasion; Management.

Unit 7

Energy (6 lectures)
Renewable and non-renewable sources of energy

Unit 8

Contemporary practices in resource management (8 lectures)
EIA, GIS, Participatory Resource Appraisal, Ecological Footprint with emphasis on carbon footprint, Resource Accounting; Waste management.

Unit 9

National and international efforts in resource management and conservation (4 lectures)

Practical

1. Estimation of solid waste generated by a domestic system (biodegradable and non biodegradable) and its impact on land degradation.
2. Analyses for pH, hardness, TDS, Alkalinity, COD and BOD of water samples from various sources.
3. Diversity indices in field based/simulation experiment.
4. Collection of data on forest cover of specific area. Measurement of dominance of woody species by DBH (diameter at breast height) method.
5. Calculation and analysis of ecological footprint (carbon footprint using UN/WWF carbon calculator).

References

1. Vasudevan, N. (2006). *Essentials of Environmental Science*. New Delhi, India: Narosa Publishing House.
2. Singh, J. S., Singh, S.P. and Gupta, S. (2006). *Ecology, Environment and Resource Conservation*.New Delhi, India: Anamaya Publications.
3. Rogers, P.P., Jalal, K.F. and Boyd, J.A. (2008). *An Introduction to Sustainable Development*. New Delhi, India: Prentice Hall of India Private Limited.

Teaching Learning Process

Theory: The Class room teaching are integrated with practical classes, and field visit to impart a sound understanding of the course. The theory topics are covered in lectures with the help of blackboard teaching and Power Point presentations. When the entire syllabus is completed, a few lectures are devoted to discuss the previous years' question papers.
Practicals: Every practical session begins with detailed instructions, followed by students conducting the experiment/s in the laboratory/field. When all the students have collected the data, the observations are discussed. Any deviation from the expected trend in results is explained. The students are encouraged to use online software, graphically represent the data and record the experiment during class hours. The students are asked to submit their record notebooks to the teacher/s for checking.
College teachers can also form a group and prepare e-contents for theory as well as for practicals.
Visit is also be organised to a Natural Ecosystem, any degraded land/Restored site or any Institution/industry.

Teaching Learning Plan:

Week 1: Unit I
Week 2: Unit II
Week 3: Unit II
Week 4: Unit III
Week 5: Unit IV
Week 6: Unit IV
Week 7: Unit V
Week 8: Unit V
Week 9: Unit VI
Week 10: Mid semester Exam
Week 11: Mid Semester Break
Week 12: Unit VII
Week 13: Unit VIII
Week 14: Unit VIII
Week 15: Unit IX

Assessment Methods

Theory: The students are continuously evaluated based on a assignments/presentation and class test. The answer scripts of the test are returned to the students. The presentations of students are evaluated by the teacher based on the content, effectiveness of the presentation, whether any new information has been added, and lastly on the answers given by students to the questions posed by the teacher. An assignment can be given in place of the presentation.
The Internal Assessment has a break-up as 10 marks for the test, 10 marks for the presentation/ assignment and 5 marks for the attendance, and comprises 25 % of the total marks.
Assessment method

Unit No	Course learning Outcome	Teaching and Learning Activity	Assessment Task
I	Natural Resources	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
II	Sustainable Utilization	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
III	Land Utilization (agricultural, pastoral, horticultural, silvicultural); Soil degradation (magnitude of problem and cause) and management strategies; Restoration of degraded lands.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
IV	Water. Fresh water ; Marine; Estuarine; Wetlands; Threats and management strategies	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
V	Biological Resources Biodiversity-definition and types; Significance; Threats; Management strategies; Bioprospecting; IPR; CBD; National Biodiversity Action Plan).	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
VI	Forests, Definition, Cover and its significance (with special reference to India); Major and minor forest products; Depletion (deforestation and biological invasion); Management	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
VII	Energy	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
VIII	Contemporary practices in resource management	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
IX	National and international efforts in resource management and conservation	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests

Keywords

Land, Water, Biodiversity, Energy, Conservation, Management Strategies

Plant Breeding
(BHDS8)
Discipline Specific Elective - (DSE) Credit:6

Course Objectives

To gain knowledge on commercially important plants, their breeding systems and strategies employed for crop improvement.

Course Learning Outcomes

Student would be able to understand the experimental steps and methods involved in generating new varieties using classical and contemporary breeding practices.

Unit 1:

An introduction to Plant Breeding (10 lectures)

Introduction and objectives. Breeding systems: modes of reproduction in crop plants. **Self-incompatibility, male sterility and apomixis.**Important achievements and undesirable consequences of plant breeding.

Unit 2: Methods of crop improvement (20 lectures)
Introduction: Centers of origin and domestication of crop plants, plant genetic resources; Acclimatization; Selection methods: For self-pollinated, cross pollinated and vegetatively propagated plants;, Hybridization: For self, cross and vegetatively propagated plants – Procedure, advantages and limitations.

Unit 3: Quantitative inheritance (10 lectures)

Concept, mechanism, Monogenic vs polygenic Inheritance, **QTL and QTL Mapping,** Case studies in inheritance of Kernel colour in wheat, Fruit quality in tomato.

Unit 4: Inbreeding depression and heterosis (10 lectures)

History, genetic basis of inbreeding depression and heterosis; Applications.

Unit 5: Crop improvement and breeding (10 lectures)

Role of mutations; Polyploidy; Distant hybridization, **Molecular Breeding, Marker assisted selection**, Role of biotechnology in crop improvement.

Practicals (tentative species: Pea, *Brassica*, Chickpea, Wheat*)

1. Introduction to field /controlled pollinations in field and laboratory (temporal details of anthesis, anther dehiscence, stigma receptivity and pollen viability, emasculation, bagging).
2. Analysis of the breeding system of chosen crop species by calculating Pollen:Ovule Ratio
3. Calculation of Index of self-incompatibility (ISI) and Confirmation of Self-Incompatibility.
4. Study of Quantitative and qualitative characters in select crops.
6. Study of Pollinators.
7. Assessment of genetic diversity by using Molecular Markers.

References

1. Acquaah, G. (2007). *Principles of Plant Genetics & Breeding*.New Jearsey, U.S.: Blackwell Publishing.
3. Singh, B.D. (2005). *Plant Breeding: Principles and Methods*, 7th edition. New Delhi, Delhi: Kalyani Publishers.
2. Chaudhari, H.K. (1984). *Elementary Principles of Plant Breeding*, 2nd edition. New Delhi, Delhi: Oxford – IBH.

Teaching Learning Process

The theory topics are covered in lectures with the help of PowerPoint presentations and the chalkboard. Students are encouraged to ask questions. The reading list has been suitably upgraded. When the entire syllabus is completed, a few lectures are devoted to discuss the previous years' question papers, thus preparing the students for the examination.
Week 1: Unit I
Week 2: Unit I
Week 3: Unit II
Week 4: Unit II
Week 5: Field observation
Week 6: Unit III
Week 7: Unit III
Week 8: Unit IV
Week 9: Unit IV
Week 10: Mid semester Exam
Week 11: Mid Semester Break
Week 12: Field observation
Week 13: Unit V
Week 14: Unit V

Assessment Methods

The students are continuously evaluated based on a class test and the presentation given by each student. The answer scripts of the test are returned to the students and the test paper is discussed at length. Students who are absent for the test are allowed to appear for the test at a later date; the question paper is suitably modified for such students. Each student in a class is given a different topic to prepare a PowerPoint presentation. All the remaining students listen to the presentation of each student, and peer students are also encouraged to ask questions. The presentations of students are evaluated by the teacher based on the content, effectiveness of the presentation, whether any new information has been added, and lastly on the answers given by students to the questions posed by the teacher. An assignment can be given in place of the presentation. The Internal Assessment has a break-up as 10 marks for the test, 10 marks for the presentation/ assignment and 5 marks for the attendance, and comprises 25 % of the total marks.

Unit No	Course learning Outcome	Teaching and Learning Activity	Assessment Task
Unit I:	. **Plant Breeding I**ntroduction and objectives. Breeding systems: modes of reproduction in crop plants. Important achievements and undesirable consequences of plant breeding.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit II:	**Methods of crop improvement** Introduction: Centres of origin and domestication of crop plants, plant genetic resources; Acclimatization; Selection methods: For self pollinated, cross pollinated and vegetatively propagated plants; Hybridization: For self, cross and vegetatively propagated plants – Procedure, advantages and limitations.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit III:	**Quantitative inheritance, C**oncept, mechanism, examples of inheritance of Kernel colour in wheat, Skin colour in human beings.Monogenic vs polygenic Inheritance.	Class room lectures and Practical demonstration, experiments	Hands on exercises, PPT, assignments, tests
Unit IV:	**Inbreeding depression and heterosis** History, genetic basis of inbreeding depression and heterosis; Applications.		
Unit V	**Crop improvement and breeding,** Role of mutations; Polyploidy; Distant hybridization and role of biotechnology in crop improvement.		

Keywords

breeding system , reproduction, pollination, domestication of plants , genetic resources, hybridization, inheritance , inbreeding depression, crop improvement